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ARTICLES

A SURVEY OF TRINIDADIAN ARTHROPODS FOR NATURAL VIRUS INFECTIONS (AUGUST, 1953 TO DECEMBER, 1958) [1]

THOMAS H. G. AITKEN
The Rockefeller Foundation (Trinidad Regional Virus Laboratory, Port-of-Spain, Trinidad, W.I.)

Arthropod investigations of the Trinidad Regional Virus Laboratory over the past five years have dealt with a variety of subjects related directly or indirectly to virology (Aitken, 1958). Throughout this period, however, primary attention has been devoted to the search for viruses in naturally infected arthropods. Accordingly, great numbers of hematophagous species have been collected annually, identified, ground up, and inoculated into white mice.

Since August, 1953, over 800 thousand specimens have thus been treated in the form of about 7,300 pools and from them 94 strains of virus have been isolated, or about one virus for every 77 pools inoculated. If one disregards 22 mosquito strains of yellow fever virus isolated during an epidemic in 1954, this figure more closely approaches one virus for every 100 pools. On the other hand, infant mice were not recipients for original insect inoculations until 19 April, 1955. As most of our mosquito agents are pathogenic for baby mice only (at least during the early passages), conceivably the yellow fever isolates might have been replaced by an equal number of baby mouse agents, and a figure somewhere between 75 to 100 pools to a virus may thus not be completely unrealistic.

One might query the advisability of continuing the annual mass inoculation of mosquitoes. Perhaps one should be more selective in the species inoculated. Actually, during the last three months of 1958 we did exercise selection in the general collections (those not taken in chicken traps), and concentrated on about a half dozen species known or thought to be vectors of Ilhéus virus and on *Culex,* a genus that seems to be particularly associated with St. Louis virus transmission. The evidence thus far gained, however, suggests that a great variety of genera and species can be found infected in the tropics, many with viruses we know little about. Moreover, the continued isolation over a period of several years of a virus such as Ilhéus from only three species among thousands inoculated, strengthens the evidence that these species are the principal vectors in Trinidad. In an exploratory program such as ours, with a bountiful supply of unknown viruses, it seems shortsighted to pattern the work along lines established by some laboratories in temperate climates where the number of viruses and vectors is limited.

In addition to the general sampling of the arthropod population in Trinidad, the entomologist has frequently been called upon to set up special collection programs in and around houses of patients from whom a virus was isolated. There was a considerable amount of such activity in 1954 in connection with yellow fever investigations; numerous attempts were made that year to isolate yellow fever virus from *Aedes aegypti* and other mosquitoes col-

[1] The studies and observations on which this paper is based were conducted with the support, and under the auspices, of the Government of Trinidad and Tobago, the Colonial Development and Welfare Scheme, and The Rockefeller Foundation.

Presented at the 15th Annual Meeting of the American Mosquito Control Association, 13–15 April, 1959, Salt Lake City, Utah.

lected in houses of suspect fever cases—none of them, however, successful.

COLLECTING AND TRANSPORTING INSECTS. The following remarks apply mainly to adult mosquitoes since these constitute our principal study material.

Mosquitoes are caught with plastic aspirator tubes and blown into pint ARC-LID Mason jars fitted with inverted perforated plastic cones in the screw-cap lid. These jars are lined with plaster of paris, which provides the mosquitoes with humidity (when it is moistened) as well as with a better surface on which to cling. The cone lids are plugged with a bit of cotton to prevent any escapes and during transit to the laboratory the jar tops are covered with a square of cloth held in place with rubber bands. No attempt is made to ice the live insect catch until it is ready for transportation to the lab. Ordinarily not more than 200 mosquitoes are put in one jar, but on occasion, when densities are high and jars scarce, there have been as many as 400 per jar.

Heleids (*Culicoides*) and other small Diptera are likewise collected by aspiration and kept in the same jars with the mosquitoes. This is admittedly not good practice, since the *Culicoides* in particular may escape through the perforations of the cone, but thus far we have hesitated to provide our mosquito catchers with an additional special bottle for small Diptera. Horse flies are caught with small hand nets and lightly anesthetized in a chloroform killing tube. They are then transferred to shell vials along with a paper giving the hour and circumstances of the capture, and stored on ice as captured.

The jars and vials of insects are transported to the Port-of-Spain laboratory by taxi (at times by train) in portable aluminum ice boxes equipped with a rack to hold the jars upright. On the occasional day trip, mosquito jars are transported in Koroseal-covered, zippered "Thermo-Keep" insulated bags, 16 by 8 by 10 inches deep; the refrigerant consists of "Sno-Gel" No. 26 bricks which, when not in use, are stored in a deep freeze box. Thus far we have not had to transport routine collections more than 30 to 40 miles. The collecting period ordinarily being during the day (e.g. 7 a.m. to 3 p.m.), the mosquitoes arrive at the lab in the late afternoon. Formerly stored overnight at 4° C., they are now kept at room temperature in order to permit any engorged mosquitoes more time to digest their blood meals.

The following morning, the mosquitoes are "knocked down" with tobacco smoke and in about 15 minutes are ready for examination. (Jars formerly kept at 4° C. were first brought into a dry room, where they were kept covered securely to prevent water of condensation forming on the inside of the jar, and allowed to warm up for about 20 minutes.)

PROCESSING ARTHROPODS FOR VIRUS ISOLATION. Following anesthetization, a jar of insects is emptied into a Petri dish and the contents identified. The individual species are sorted into tubes held by a rack in an ice bath. The tubes used for this purpose are old 30 ml "Vacune" tubes (7/8-inch diameter) cut to a length of 4 inches. To prevent the insects' sticking to the glass, the tubes are lined with 3- by 5-inch sheets of weighing paper, which are wrapped around a wooden plunger for insertion into the tube. Each tube carries a recognition "flag," an applicator stick with the species name typed on a cardboard indicator. As an aid to virus survival, an attempt is made to keep the insects cold at all times except when under a microscope. A routine morning's operation may require the identification of a few hundred to several thousand mosquitoes representing 40 to 50 species.

Ordinarily it is not possible to grind and inoculate a catch the same day it is identified. Therefore, the species are stored as whole insects at —60° C. either in sealed glass ampoules in a dry ice box, or in an electric box (Revco) in open tubes which permit accumulation of additional material. Formerly engorged mosquitoes were discarded, but as they are now stored overnight at ambient temperatures, engorged and unengorged specimens are treated similarly—except that if particularly plentiful, as in the case of chicken-

trap collections, the engorged mosquitoes may be ground separately.

Ampoules of stored insects are held until sufficient numbers have accumulated and mice are available. Insects may thus be stored for a day or so up to a month. Most species are ground about twice a month, but in the season of greatest prevalence a few of the most abundant species are ground several times during the month. To make record keeping easier, stored insects are ordinarily not carried over the month.

Mosquito pools are suspended in diluent according to the following schedule: 1 ml for the first 10 mosquitoes; 2 ml for 11 to 300 mosquitoes; and 3 ml for more than 300 mosquitoes.[2] Occasionally, large pools of 700 or more specimens are broken down into two pools.

Certain mosquitoes (and ticks) are toxic to 2-day-old mice when inoculated intracerebrally (i.c.) in large numbers. In order to overcome the problem of retreating the specimen and reinoculating, during the past year a modification of the dilution schedule for certain species (e.g. *Aedes scapularis, A. serratus, Psorophora ferox,* and *Culex fatigans*) was instituted, as indicated below:

No. of mosquitoes	Original suspension (ml)	Subsequent dilution factor
300–400	3	1:2
400–600	3–4	1:3
600–1,500	4–9	1:4
1,500–2,000	9–10	1:5
2,000 plus	10	1:6

By the dilution factor, we mean that following centrifugation, the suspension is further diluted 1:2, etc. The original suspension, however, is stored for future reference.

In the case of *Psorophora ferox* and *Culex fatigans,* the 1:2 dilution factor was subsequently applied to pools of 150 to 400 mosquitoes. It has been noted that a pool of about 150 chick-blooded *Culex taeniopus* or *C. spissipes* should likewise be diluted 1:2, even though these are small species. We have been forced to resort to these measures because of the large numbers of mosquitoes confronting us at certain times of the year. While some of the pools have of necessity been large, generally they run between 20 and 50 specimens per pool. In one instance, however, we isolated Ilhéus virus from a pool of 2,055 *Aedes serratus* suspended in 6 ml diluent and further diluted 1:6, and there have been many isolations from pools of 200 to 700 mosquitoes.

With respect to other arthropod suspensions, we have adopted roughly the following schedule (trying to keep diluent to a minimum at all times):

Phlebotomus, simuliids, Anoplura, Mallophaga—100 per 1 ml.

Culicoides and mites—500 per 1 ml.

Tabanids—2 ml for 1 to 10 flies, thereafter 1 ml for every 10 flies.

Philornis—1 to 4 flies in 1 ml, 5 to 20 in 2 ml, 20+ in 3 ml.

Ticks—These are more difficult to handle because they are laden with bacteria and fungi, particularly if kept alive in small tubes for some time. Unengorged nymphs, about 100 per 1 ml; engorged nymphs 5 per ml; males up to 20 in 1 ml and engorged females about 1 to 2 ml per tick. Ticks engorged with cattle blood are toxic. Since filtration is useless, specimens must be diluted. Ticks have also been successfully inoculated after being cleansed in 70 percent alcohol.

Following grinding, suspensions are centrifuged at 8,000 r.p.m. for 1/2 hour at 4° C. Subsequently 2-day-old mice receive an inoculum of 0.02 ml i.c. and the remainder is stored at —60° C. Mice are held 21 days for signs of illness before be-

[2] The diluent in which mosquitoes are triturated is composed of 0.12 molar NaCl; 0.006 molar NaH_2PO_4; 0.012 molar $NaHPO_4$; and 0.75 percent fraction 5 bovalbumin. The pH is adjusted to between 6.8 and 7.3 by the addition of 0.3 molar NaOH solution. Sterilization is effected by filtration through a Seitz-EK pad. Crystalline penicillin G and streptomycin sulphate are added to produce a final concentration of 400 units per ml of the former and 250 μg per ml of the latter.

TABLE 1.—Trinidadian mosquitoes inoculated into adult and baby mice, 1953–1958

Species	No. mosquitoes inoculated into mice	
	Adult	Baby
Aedes aegypti	25	3
fulvithorax	258	468
fulvus	56	1,741
hortator	36	1,613
ioliota	72	
leucocelaenus	253	18
scapularis	580	46,592
serratus	2,046	115,621
sexlineatus	9,995	866
taeniorhynchus	3	833
terrens	161	3
sp.	140	
Anopheles apicimacula	335	1
aquasalis	20,900	3,863
bellator	16,818	5,302
eiseni	20	
homunculus	14,880	503
mediopunctatus	168	3
neomaculipalpus	44	21
nimbus	11	276
oswaldoi	258	332
sp.		46
Culex caudelli		7,812
corniger		1
coronator		480
gairus		5
gaudeator		6
mollis		1
nigripalpus	12	3,768
quinquefasciatus	201	9,660
spissipes	365	5,323
stonei		3
taeniopus	56	1,752
urichi	1	42
virgultus		251
sp. #2		481
sp. #3		286
sp. #7		212
sp. #8		971
sp. #9		1
sp. #10		740
sp. #11		163
sp. #12		35
sp. #13		144
sp.	2,524	2,242
Haemagogus spegazzinii	5,686	9,147
Limatus durhami	1,546	9,770
flavisetosus	3,767	27,287
Mansonia arribalzagai	173	50,116
titillans *	694	2,134
venezuelensis	2,224	8,487
Orthopodomyia fascipes		4
Phoniomyia fuscipes (?)	1,008	15
lassalli	1	17,278
splendida	1,127	3,291
trinidadensis	4,814	24,440
Psorophora albipes		58,216
cingulata	13,636	3,722
ferox	4,380	61,879
lineata		1
lutzi	321	2,595
sp.	105	
Sabethes belisarioi		9
chloropterus	191	858
cyaneus	1	123
undosus	1,665	201
Trichoprosopon digitatum	147	956
longipes	2,295	914
theobaldi	13,389	2,306
Wyeomyia aporonoma	11,354	2,019
arthrostigma	1	1,715
autocratica		508
circumcincta (?)		21
clasoleuca (?)		895
felicia	26	316
finlayi		2,510
hemisagnosta (?)		22
howardi	3	13,588
kerri	3	107
medioalbipes	2,296	6,895
melanocephala	1	2,445
melanopus (?)		205
personata (?)		1
pseudopecten	1	1,293
scotinomus	13,326	411
ulocoma		13
ypsipola		5,259
sp. near *serrata*	143	
sp.	134,831	18,752
Total	289,373	553,208

* Species previously referred to by us as *Mansonia wilsoni*.

ing discarded. Specimens in litters with 4/7 mortality ratio or higher are reinoculated.

Arthropods Surveyed. In the five years and 4-1/2 months during which Trinidadian arthropods have been processed in the search for natural virus, 842,581 mosquitoes and 13,262 other arthropods have been inoculated into adult and baby mice—a grand total of 855,843 arthropods processed. Adult mice were the recipients of 290,804 arthropods and infant mice of 565,039 arthropods.

The 84 species of mosquitoes and the numbers of each inoculated into the two types of mice are presented in Table 1. The six most commonly tested species are (approximate figures): *Aedes serratus* (118,000), *Psorophora ferox* (66,000), *Psorophora albipes* (58,000), *Mansonia arribalzagai* (50,000), *Aedes scapularis* (47,000), and *Limatus flavisetosus* (31,000).

Inoculations are presented on a generic basis in Table 2 and Fig. 1. It will be noted that *Wyeomyia* is the genus most commonly inoculated. Almost three quarters of these Wyeomyias were handled during a period early in the history of the laboratory when we were not differentiating species in this rather difficult genus either through lack of time or because of unfamiliarity with the group. In 1953–54 and early in 1955, when only adult mice were inoculated with original mosquito material, the principal genera inoculated were *Wyeomyia, Anopheles, Psorophora, Trichoprosopon,* and *Aedes.* Much of the work in those days was in mountainous districts and mangrove swamps. Since the change-over to suckling mice in April, 1955, the scene of activities has changed to lowland swamp-forest and cocoa and citrus plantations, characterized largely by ground pool and permanent water breeding species. As a result *Aedes* and *Psorophora* have become the dominant genera encountered, followed by *Mansonia* and the ubiquitous Wyeomyias. In this latter period there has also been a noteworthy increase in the collections of *Phoniomyia, Limatus,* and *Culex.*

In the non-mosquito groups (Table 3), little testing was done until the past few years. *Culicoides* and simuliids have received the greatest attention. Obviously more work needs to be done with these and related groups before it can be said that they have been adequately sampled. The chalcids were included because they were parasitizing *Philornis* pupae, which in turn came from larvae parasitic on a nestling silver-beak tanager from which St. Louis virus was isolated. The genus *Philornis* represents a group of flies most of which are parasitic on fledgling birds in the Neotropical Region. They have been shown to constitute a highly

TABLE 2.—Trinidadian mosquitoes, by genera, inoculated into adult and baby mice (1953–1958)

	Adult mice	Baby mice	Grand total
Aedes	13,625	167,758	181,383
Anopheles	53,434	10,347	63,781
Culex	3,159	34,379	37,538
Haemagogus	5,686	9,147	14,833
Limatus	5,313	37,057	42,370
Mansonia	3,091	60,737	63,828
Orthopodomyia		4	4
Phoniomyia	6,950	45,024	51,974
Psorophora	18,442	126,413	144,855
Sabethes	1,857	1,191	3,048
Trichoprosopon	15,831	4,176	20,007
Wyeomyia	161,985	56,975	218,960
Total	289,373	553,208	842,581

NUMBERS OF TRINIDADIAN MOSQUITOES, BY GENUS, INOCULATED INTO ADULT AND BABY MICE AND POOLS POSITIVE FOR VIRUS 1953-1958

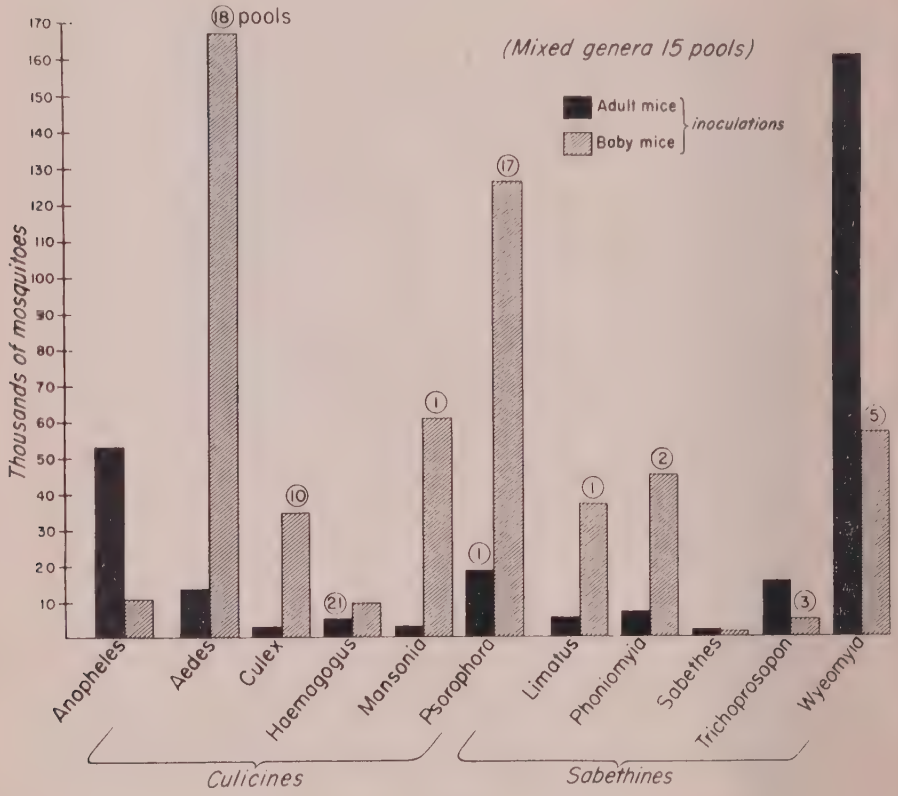

FIG. 1.

favorable medium for virus growth (Aitken, *et al.*, 1958), and because of their hematophagous habits could conceivably occupy a niche in some virus transmission cycle. Arthropod inoculations by group and year are summarized in Table 4.

VIRUSES ISOLATED. Since 1953, a total of 94 viruses have been isolated from arthropods—all from mosquitoes. As shown in Table 5, these have been classified into 15 distinct agents on the basis of immunological studies carried out in this laboratory; included in the table are the species of mosquitoes from which the strains were isolated as well as the number of strains obtained from each. Table 6 summarizes virus isolations by genus of mosquito.

Twenty-four of these viruses were isolated in 1954 from adult mice. Of this number, 22 represented strains of yellow fever virus (Downs *et al.*, 1955) and two were strains of Ilhéus virus (Anderson *et al.*, 1956).

All of the remaining 70 strains, representing 14 agents, have been isolated in infant mice since April, 1955. Three of these agents are previously known viruses —Ilhéus, St. Louis (Anderson, Aitken *et al.*, 1957), and Mayaro (Anderson, Downs *et al.*, 1957)—but most of the other 11

TABLE 3.—Trinidadian arthropods other than mosquitoes inoculated into adult and baby mice, 1953–1958

Species	No. arthropods inoculated into mice: Adult	Baby
Simuliids		
Simulium incrustatum	22	1,170
metallicum	62	54
samboni	343	2,014
Total	427	3,238
Heleids		
Culicoides debilipalpis	0	13
diabolicus	0	5,315
sp.	0	1,180
Total	0	6,508
Psychodids		
Phlebotomus sp.	952	20
Tabanids		
Acanthocera sp.	0	84
Chlorotabanus inanis	0	2
mexicanus	0	2
unicolor	0	16
Chrysops variegata	0	269
Leucotabanus exaestuans	0	87
Stibasoma fulvohirtum	0	139
mallophoroides	0	54
Tabanus colombensis	0	7
lineola var. *carneus*	0	364
sorbillans	0	54
xipe	0	86
Total	0	1,164
Anthomyiids		
Philornis sp. (several)	0	346
Chalcids		
Spilochalcis sp.	0	2
Mallophagans		
Chicken lice	0	161
Ticks		
Amblyomma cajennense	0	111
dissimile	0	3
longirostre	0	8
Boophilus microplus	47	173
Rhipicephalus sanguineus	0	47
Total	47	342
Mites		
Dermanyssids	5	50
Grand Total	1,431	11,831
		13,262

TABLE 4.—Trinidadian arthropods, by years, ground and inoculated into mice (August, 1953–31 December, 1958)

Arthropods	1953	1954	1955	1956	1957	1958	Total
Mosquitoes	10,126	278,866	154,861	76,549	151,155	171,024	842,581
Culicoides	0	0	1,497	65	367	4,579	6,508
Simuliids	0	427	379	775	1,162	922	3,665
Tabanids	0	0	0	0	509	655	1,164
Phlebotomus	0	952	20	0	0	0	972
Ticks	0	47	0	0	0	342	389
Philornis	0	0	0	0	0	346	346
Lice	0	61	100	0	0	0	161
Mites	0	0	5	0	0	50	55
Chalcids	0	0	0	0	0	2	2
Total	10,126	280,353	156,862	77,389	153,193	177,920	855,843

Note: All arthropods in 1953 and 1954, and 381 mosquitoes in 1955 inoculated into adult mice; remainder inoculated into baby mice.

TABLE 5.—Preliminary classification of viruses isolated from Trinidadian mosquitoes, 1953–1958

Classification Prototype virus	Total # strains	Collection site	*Source of virus* Mosquito species	No. strains by mosq. sp.
Mayaro				
TR 15537	1	Rio Grande Forest	*Mansonia venezuelensis*	1
Yellow fever	22	Melajo Forest	*Haemagogus spegazzinii*	8
TR 2942			Mixed pool	1
		Charuma Forest	*Haemagogus spegazzinii*	13
St. Louis	6	Melajo Forest	*Culex caudelli*	1
TR 9464			*Psorophora ferox*	1
		Arena Forest	*Culex coronator*	1
		Vega de Oropouche	*Culex coronator*	1
			Culex spissipes	1
			Culex taeniopus	1
Ilhéus	18	Melajo Forest	Mixed pool	1
3089 (Brazilian strain)		Charuma Forest	*Psorophora* pool	1
		Rio Grande Forest	*Psorophora ferox*	6
			Aedes serratus	3
			Aedes scapularis	2
			Psorophora pool	1
			Mixed pool	3
		Vega de Oropouche	*Culex caudelli*	1
TR 7994	1	Arena Forest	*Trichoprosopon* pool	1
TR 8349	17	Rio Grande Forest	Mixed pool	9
			Aedes scapularis	2
		Melajo Forest	*Psorophora albipes*	1
			Limatus pool	1
			Aedes scapularis	2
			Trichoprosopon longipes	1
		Vega de Oropouche	*Psorophora* pool	1
TR 8362	1	Melajo Forest	*Culex* pool	1
TR 8762	4	Melajo Forest	*Psorophora albipes*	2
			Psorophora ferox	2
TR 8900	11	Melajo Forest	*Aedes scapularis*	4
			Psorophora ferox	2
			Wyeomyia pool	2
			Wyeomyia aporonoma	1
			Culex spissipes	1
		Rio Claro	*Wyeomyia ypsipola*	1
TR 9223	6	Melajo Forest	*Trichoprosopon theobaldi*	1
			Wyeomyia pool	1
		Rio Grande Forest	*Phoniomyia* pool	2
			Psorophora ferox	1
		Vega de Oropouche	*Culex sp.* #7	1
TR 9375	1	Melajo Forest	*Aedes scapularis*	1
TR 10076	3	Melajo Forest	*Aedes scapularis*	2
		Rio Grande Forest	*Aedes scapularis*	1
TR 11573 (ex Artibeus)	1	Rio Grande Forest	Mixed pool	1
TR 18462	1	Rio Claro	*Culex sp.* #8	1
TR 20659	1	Rio Grande Forest	*Aedes scapularis*	1
Total	94			94

TABLE 6.—Virus isolations in Trinidad according to arthropod source (1953–1958)

Mosquito genus	Virus															
	YF	Ilhéus	SL	Mayaro	7994	8349	8362	8762	8900	9223	9375	10076	11573	18462	20659	Total
Culex		1	5				1		1	1				1		10
Mansonia				1												1
Aedes		5				4			4		1	3			1	18
Psorophora		8	1			2		4	2	1						18
Haemagogus	21															21
Trichoprosopon					1	1				1						3
Wyeomyia									4	1						5
Phoniomyia										2						2
Limatus						1										1
Mixed	1	4				9							1			15
Total	22	18	6	1	1	17	1	4	11	6	1	3	1	1	1	94

appear to be new to science, although some show relationships to viruses isolated in other parts of the Western Hemisphere.[3]

A number of mosquito genera are included in the list of suspect vector species (Fig. 1): *Mansonia, Culex, Aedes, Psorophora, Trichoprosopon, Limatus, Wyeomyia,* and *Phoniomyia.* The species most frequently found infected are *Aedes scapularis, Psorophora ferox,* and *P. albipes.* It is unfortunate that mixed pools were the source of virus in several instances; these were unavoidable happenings at times when few mice were available for virus isolation attempts.

SUMMARY. Techniques are reported for the processing of Trinidadian arthropods for recovery of naturally occurring virus. Mosquitoes have been the principal group investigated. Tables are presented listing the numbers of the various species inoculated into adult and baby mice and the numbers and kinds of viruses isolated from them during the period August, 1953 to December, 1958.

[3] One of these, TR 8900, has now been named Kairi virus (Anderson *et al.,* 1960) and has been shown to be related to Wyeomyia and Bunyamwera viruses (Casals and Whitman, 1960).

References

AITKEN, T. H. G. 1958. Entomological aspects of the Trinidad virus research program. Proc. Tenth Internat. Cong. Ent. 3:573–580.

AITKEN, T. H. G., DOWNS, W. G., and ANDERSON, C. R. 1958. Parasitic *Philornis* flies as possible sources of ARBOR virus infections (Diptera: Anthomyidae). Proc. Soc. Exp. Biol. and Med. 99:635–637.

ANDERSON, C. R. AITKEN, T. H. G., and DOWNS, W. G. 1956. The isolation of Ilhéus virus from wild caught forest mosquitoes in Trinidad. Amer. J. Trop. Med. and Hyg. 5:621–625.

ANDERSON, C. R., AITKEN, T. H. G., DOWNS, W. G., and SPENCE, L. 1957. The isolation of St. Louis virus from Trinidad mosquitoes. Amer. J. Trop. Med. and Hyg. 6:688–692.

ANDERSON, C. R., AITKEN, T. H. G., SPENCE, L., and DOWNS, W. G. 1960. Kairi virus, a new virus from Trinidadian forest mosquitoes. Amer. J. Trop. Med. and Hyg. 9(1):70–72.

ANDERSON, C. R., DOWNS, W. G., WATTLEY, G. H., AHIN, N. H., and REECE, A. A. 1957. Mayaro virus: a new human disease agent. II. Isolation from blood of patients in Trinidad, B.W.I. Amer. J. Trop. Med. and Hyg. 6:1012–1016.

CASALS, J., and WHITMAN, L. 1960. A new antigenic group of arthropod-borne viruses: The Bunyamwera Group. Amer. J. Trop. Med. and Hyg. 9(1):73–77.

DOWNS, W. G., AITKEN, T. H. G., and ANDERSON, C. R. 1955. Activities of the Trinidad Regional Virus Laboratory in 1953 and 1954 with special reference to the yellow fever outbreak in Trinidad, B.W.I. Amer. J. Trop. Med. and Hyg. 4:837–843.

IMPROVED METHODS OF FORMULATING GRANULAR PARIS GREEN LARVICIDE[1]

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A previous report described a granular paris green-vermiculite formulation for use against culicine and anopheline larvae (Rogers and Rathburn, 1958). This formulation is made by coating the outer surface of vermiculite granules with paris green powder by use of a water-miscible sticker. When applied to water the granules float for several hours, during which time the paris green is released through action of a wetting agent in the sticker. The powder settles slowly through the water where it is consumed by subsurface-feeding larvae either as it settles or after it comes to rest on the soil, grass stems, debris, etc. Some of the released paris green floats at the surface for considerable time where it is available to anopheline larvae. Thus, the granular formulation seems to meet the requirements of an all-purpose mosquito larvicide.

The original formulation was made with a 60 percent motor oil emulsion as the sticker. The emulsion had two disadvantages: it was difficult to apply as a fine spray to the vermiculite and it contained water which had to be removed from the formulation. This required extra handling and a large amount of floor space for processing.

Research in 1958 resulted in replacement of the emulsion sticker by an emulsifiable oil, which is easy to apply as a spray and requires no drying of the formulation. The emulsifiable oil is made by adding an emulsifier to a horticultural-type spray oil.

Oil. Oils tested were Standard Oil Company's No. 341 and No. 345 spray oils, and Gulf Oil Company's No. 361 and No. 562 spray oils. In laboratory tests, all of these oils performed about equally as stickers for the paris green.

These oils, with 10 percent by volume of Triton N-101,[2] were further tested in identical formulations against larvae of *Aedes taeniorhynchus* in randomized and replicated field tests. (All tests reported in this paper were in plots 200 square feet in size.) Oils No. 345 and 562 were compared in the same test in a pickleweed salt marsh. Oils No. 341 and 361 were tested together in a mangrove salt marsh. All dosages were 0.6 pound per acre of paris green, applied by hand as six pounds per acre of a 10 percent paris green formulation. Results are shown in Table 1. There were three replications of each treatment.

TABLE 1. Field tests comparing four spray oils as stickers in a vermiculite-paris green formulation against larvae of *Aedes taeniorhynchus* Wied.

Oil No.	Avg. no. larvae/dip: Pre treatment	Post treatment	Percent reduction	Type Marsh
345	22.1	1.5[1]	93	Pickleweed
562	19.4	1.1[1]	94	
341	93.4	0.0[2]	100	Mangrove
361	100.0	2.0[2]	98	

[1] 24 hours.
[2] 18 hours.

Emulsifiers. Rapid and complete water solubility appear to be important requirements for the emulsifier-wetting agent in this formulation. Viscosity and other physical factors, as well as chemical factors, may also play a part both in helping

[1] A paper from the Proceedings of the 15th annual meeting of the AMCA, Salt Lake City, April, 1959.

[2] Rohm & Haas Co.

to stick the paris green on the granules and in releasing the toxicant at the proper rate, but no detailed studies have been made to determine the effects of all these factors. Laboratory tests indicated, however, that oil-soluble emulsifiers do not perform as well as water-soluble emulsifiers.

Only Triton N-101 and Tween 20[3] emulsifiers were field-tested against larvae of *Aedes taeniorhynchus* in these studies. These were compared at concentrations of 5 percent and 10 percent by volume in 10 percent paris green formulations, using No. 345 oil as the sticker. Dosage was six pounds per acre gross applied in a pickleweed salt marsh. Results are shown in Table 2. There were three replications of each treatment, except the check.

TABLE 2.—Field tests comparing two emulsifiers in a vermiculite-paris green formulation against larvae of *Aedes taeniorhynchus* Wied.

Treatment	Avg. No. larvae/dip		
	Pre treatment	24 hours	% Reduction
Triton 5%	30.5	1.4	95
Tween 5%	28.4	8.7	69
Triton 10%	21.3	0.0	100
Tween 10%	37.0	10.3	72
Check[1]	13.8	14.0	—

[1] Two replications.

Judged only by the results shown in Table 1, it might appear that oils No. 341 and No. 361 were slightly superior in these tests. However, other tests (see Table 3) and use experience have shown that granular paris green using the No. 345 or No. 562 oil will give excellent larval kills in mangrove marshes. Pools in these marshes are free of weeds and the bottom is covered with mangrove leaves. These physical conditions permit complete coverage and the broad, flat mangrove leaves on the soil apparently form an ideal substrate upon which the paris green powder may settle and remain available to subsurface-feeding larvae. Therefore, any apparent differences in the performance of the oils that may be indicated in Table 1 probably reflect differences in marsh conditions rather than in the oils. Cost would seem to be the most important factor in selecting one of these oils. Other spray oils probably could be used, but they should first be tested to ascertain their performance in the formulation.

Data in Table 2 show that Triton N-101 was superior in these tests, but a good explanation for these results is not apparent. There probably are a number of other emulsifiers or wetting agents that would work well in this formulation, but these data show that they should be selected only after adequate testing.

The data also indicate that Triton N-101 at 5 percent by volume was only slightly less effective than the 10 percent volume. But again, use experience and the slight difference in costs seem to justify using the 10 percent volume.

VERMICULITE. For application by hand-casting, a No. 4 Zonolite or Institute grade of vermiculite of which at least 90 to 95 percent by weight is retained on a No. 30 U. S. Standard Sieve appears to be satisfactory as the granular base. However, for aerial application, and probably for ground application by mechanical equipment, a more uniform grade of vermiculite is necessary to ensure uniform distribution and dosage. Good progress has been made toward the production of a suitable grade of vermiculite for aerial or other mechanical applications of this formulation but final specifications have not been determined.

FORMULATING PROCEDURE. The procedure for formulating granular paris green with emulsifiable oil basically is the same as previously described (Rogers and Rathburn, 1958). The vermiculite is placed in a rotating drum (cement-type mixer) and with the drum rotating the oil-emulsifier mixture is sprayed over the vermiculite as a fine spray of mist. The emulsifier is not soluble in the oil and tends to settle to the bottom of the spray tank

[3] Atlas Powder Co.

rather rapidly. Therefore it is essential that frequent or constant agitation be applied to the sticker as it is being sprayed. After the emulsifiable oil is thoroughly mixed with the vermiculite, the paris green powder is added in small quantities and mixing is continued until the formulation appears uniformly green in color. This formulation may be bagged directly from the mixer and is ready for use; no drying is necessary.

Standard Formula. For uniform weight and quality it seems desirable to standardize the formulation. The recommended standard formula contains by weight 53 pounds of vermiculite, 17 pounds of powder, and 30 pounds of emulsifier-oil sticker per 100-pound batch. Using commercial 90 percent paris green powder, this formula makes 100 pounds of 15 percent paris green by weight.

To make a finished product on the standard formula containing less than 15 percent paris green, the 90 percent paris green is first diluted with a heavy dust, like calcium carbonate (marble dust). For example, to make 100 pounds of 10 percent granular paris green on the standard formula, use 17 pounds of a calcium carbonate-paris green blend which contains 60 percent by weight of paris green.

Dosage Recommendations. Numerous field tests in 1958 showed the improved, standard formulation to be as effective as the original formulation against larvae of *Aedes taeniorhynchus*. Typical data from tests conducted in a mangrove marsh are shown in Table 3. Some of the treatments were replicated in time during September, 1958. Formulations were made either with No. 345 or No. 562 oil, as indicated.

Two years of experience in testing granular paris green by ground application against larvae of *Aedes taeniorhynchus* have shown that a dosage of 0.6 pound per acre of toxicant is adequate to control this species where physical conditions in the breeding area permit good coverage, and where the larvae are well dispersed. There are situations and conditions, however, where this dosage rate is not adequate.

In breeding areas overgrown with thick vegetation, and in any situation where larvae become concentrated in large numbers in small areas of water, as in wheel ruts or in holes left by a receding water level, the dosage rate should be doubled or tripled to ensure good results. Presumably, this is due to the fact that paris green acts only as a stomach poison and under these conditions of concentrated larval populations not enough toxicant is available per larva at low dosage rates. Spot-treating with larger dosage rates under these conditions should not increase the cost per acre, because considerably less area is treated than when larvae are more widely dispersed. In the case of *Aedes taeniorhynchus* and *Aedes sollicitans,* concentrations of larvae occur from normal behavior of the third and fourth instar larvae, even in well-flooded marshes. Since spot-treating of these "balls" of larvae cannot be accomplished by aerial application, this might prove to be an important dosage factor for aerial treatment of these species.

Since conditions vary so widely in different areas, dosage rates can probably best be determined by use experience in any given area. As a starting point, it is suggested that a 10 percent formulation be

TABLE 3.—Dosage and volume tests against larvae of *Aedes taeniorhynchus* Wied. using improved, standard formulation of granular paris green

Formulation (percent paris green)	Dosage lbs./acre (gross)	Avg. No. larvae/dip		Number replications	Percent reduction
		Pre treatment	Post treatment		
7.5	8	71.3	0.03	3	99.95
10.0	6	80.3	0.10	3	99.87
10.0[1]	6	16.7	0.00	1	100.00

[1] Formulation made with No. 562 oil.

tried at a rate of 10 pounds per acre. The 10-pound rate will ensure better coverage, which is very important with this larvicide, and the required amount of toxicant can be determined by varying the paris green content of the formulation.

Although a number of highly successful tests have been made with aerial applications of granular paris green, this work is not sufficiently advanced to permit general recommendations for airplane application at this time.

References

ROGERS, ANDREW J. and CARLISLE B. RATHBURN, JR. 1958. Tests with a new granular paris green formulation against *Aedes, Anopheles,* and *Psorophora* larvae. Mosquito News 18(2):89–93.

AN ANALYSIS OF THE ERADICATION CONCEPT

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FOREWORD BY THE EDITOR

Before Harold Gray delivered his paper, "An Analysis of the Eradication Concept," at the 15th Annual Meeting of the AMCA held in Salt Lake City in April, 1959, he sent a copy of it to Dr. Louis L. Williams so that the latter could review it and be prepared to comment on it at the meeting. The program was arranged so that Dr. Williams was given time to discuss the paper immediately following its presentation. Later, it was requested that a transcript of the tape recording of Dr. Williams' remarks be published along with Mr. Gray's paper when it appeared in *Mosquito News*—a sort of "equal time" arrangement. Unfortunately, the tape recording was a total loss, so that in order to have both sides of the question presented in one number of *Mosquito News* we are publishing Mr. Gray's paper, with lettered footnotes at various points, which refer to comments made by Dr. Williams (and, in some instances, by others) in letters to Mr. Gray or to the Editor.

There is a feeling on the part of many that the difference between an eradication and a control program may often be largely semantic. The speaker and the listener do not always have the same idea as to the meaning of the term, and all too often the speaker does not listen and the listener does not speak, so that the differences never become resolved. The chief argument on the questions raised here seemed to be not whether some of the methods described should or should not be a part of the malaria eradication program, but, rather, whether they are or are not already in practice.

It is the hope of the editor and of the committee on publications, who have been consulted in the matter, that by presenting the paper of one distinguished authority with footnotes by another, the questions at issue may be somewhat clarified.—Editor

PREFACE. At the AMCA meeting in Washington, D. C., in February, 1958, Dr. Fred L. Soper presented a paper (1) in which he traced the change in attitude and orientation in the world-wide campaign against malaria, from the concept of control to the present concept of eradication. He described the remarkable progress which has been made in eliminating malaria from extensive areas of the world, and looked forward to the eventual consummation—the extirpation of the malaria plasmodium from the blood stream of man throughout the world.

Undoubtedly all good men agree with the desirability of the project and applaud its purposes. They also respect the able men whose skill and devotion to an ideal have brought so laudable an intention into the realm of possibility. With their purpose there can be no quarrel. But with their methods there can legitimately be some difference of opinion.

INTRODUCTION. The concept of the eradication of a vector-transmitted disease from a region, as contrasted with the concept of control, has attained world-wide acceptance in recent years. This has been particularly true of malaria, where the success of certain methods or techniques has been spectacularly successful in definite regions. This eradication technique has been based almost entirely on the use of insecticides,[a] it may be self-limiting due to a number of factors, and appears to have certain inherent problems which may prevent its success over a long period of time.

Some of these problems, or difficulties, are economic, some sociological, and others technical. They will be referred to briefly, as time will not permit an extensive or detailed examination of them. It is hoped that enough can be presented to stimulate further thinking on the subject.

The primary difficulty is a formalism which applies one and only one technique of eradication[a] under all circumstances and conditions, among peoples of widely varying cultures, under markedly different climates, with different topographies, different agricultures, divergent types of urban development, and against mosquitoes of quite varied ecologies. This use of one technique only may frequently ignore the use of other methods which may have both direct and indirect benefits of real value. Above all, it ignores one of the most important lessons in the history of disease, that certain environmental changes, some minor and some major, have resulted eventually in the elimination of a disease.[b]

BASIC POSTULATES IN THE CONTROL OF A VECTOR TRANSMITTED DISEASE. Before entering into an examination of the eradication concept it will be desirable to present briefly the basic postulates in the control of any vector-transmitted disease.

By a vector-transmitted disease we imply a disease of either man or other animals, the causative organism of which is transmitted by another living organism (a vector) which is an essential factor either in the life cycle of the causative organism or in its transmission.

Given the transmission of a communicable disease by a living vector, the disease can be controlled or even extirpated from an area, large or small, by one or more of several methods, such as

1. Exterminate the vector or reduce its numbers in relation to the number of hosts to a ratio at which the disease will not be able to maintain itself—that is, to a point at which there will be less than one new infection for every infection terminated by death, cure or departure;

[a] "I do not view it this way. Use of insecticides is, today, the basic professional technique for *control* just as it is for *eradication*. The technique which distinguishes eradication from control is an administrative technique, not a professional one. As early as 1881 Chapin pointed out that if we can control a disease we can eradicate it. Eradication is merely setting up an operational methodology which carries control to the nth degree, controls 'completely' the last focus of infection by removing it."—L.L.W. (See Foreword by the editor referring to remarks by L. L. Williams).

[b] [Residual insecticides] "are the *principal* professional techniques because of their low cost and ease of application, but are not the *one and only*. Where residuals do not work, other professional techniques are in use—and with success."—L.L.W.

2. Eliminate susceptible hosts in reservoir animals or man, or reduce their numbers by removal or immunization to the point where new infections do not keep pace with those which cease to be infective;
3. Exterminate the causative organisms in the hosts or vectors, or reduce the numbers of organisms in the hosts below the effective level for infection of the vectors;
4. Prevent the vectors from making one or the other of the TWO BITES necessary for transmission of the disease—the first (on an infected man or animal which infects the vector—the second (after the interval required to render the vector infective) on a susceptible host. This can be done by isolating the carrier or the susceptible host from the vector; by killing the vector before it can make either the first or the second bite; or by deviation of the vector to a non-infectible animal.

For simplicity in this discussion the term "vector" is restricted to the disease-transmitting arthropod, even though technically in some diseases it is the definitive host.

ANALYSIS OF THE BASIC POSTULATES. In the sixty years since the method of transmission of malaria and yellow fever has been known, all four of the aforesaid methods of control have been used with varying degrees of success. Even with the methods available prior to 1945 successful control of malaria and yellow fever had been obtained in many parts of the world by control of the specific vectors, and in at least one instance a vector species had been eradicated from a very large area (Northern Brazil) (2).

In general, however, it did not appear to be practicable to exterminate vector species in any large area, for a number of reasons, one of them being the high cost of extermination, and another being the possibility of the reintroduction of the vector after its extermination had been accomplished. The concept that the disease could be extirpated even in the presence of considerable numbers of vectors could not at that time be envisioned as a normal possibility. But it was practicable, within reasonable limits of effort, time and money, either to modify the environment in a manner adverse to the production of appreciable numbers of the vectors, or to directly attack the vectors by larvicidal measures. It was effective to use both methods, so that the ratio of vectors to victims was lowered rapidly to a point where transmission of the causative organisms ceased and the disease died out in an area.

The critical ratio of vectors to human population varies with climate, with the characteristics and transmission potential of the vector species, with the type of environment, and with the culture of the hosts. Within reasonable limits this ratio can be expressed statistically and numerically (3, 4). In some regions, mainly tropical, and with some species of vectors with a high transmission potential, the ratio of vectors to hosts is low for the continuous or endemic presence of the disease, but in other regions or with vectors of low transmission potential the ratio of vectors to hosts is much higher. In the first case control of the disease has proved to be difficult and has required a multiple attack method and considerable expenditure of effort, time and money. In the second case comparatively slight efforts have produced spectacularly successful disease control and even extirpation of the disease in limited areas.

Many efforts at control were directed at the reduction of the number of vectors by attacks against the larval stages of the vectors, since it was generally the case that attacks upon the adult stages were relatively ineffective, or inefficient in terms of effort and money. However, in some situations attempts were made to set barriers between hosts and vectors, as by screening, either as a sole method or as a supplement to larval control. And drugs were also used in the hope of minimizing the number of infected hosts available to the vectors.

Attempts to control some vector-transmitted diseases by direct attacks upon the causative organisms generally have not been successful.[c] Both the use of drugs, and the use of vaccines to produce immunity in the hosts, have been tried. In malaria control as an example, until recently no drugs were available which dependably could eliminate the parasite from the host as a mass medication scheme. Experience with recent drugs of greater effectiveness has not gone far enough for us to make too positive statements, but subject to certain known problems with mass medication of humans there appears to be hope the new drugs can be valuable adjuncts in some malaria control or eradication projects. For example, the incorporation of chloroquine or pyrimethamine in the culinary salt supply gives promise of useful results with rural and perhaps even primitive populations (5).

The basic difficulty with mass medication as either a control or an extirpative method is the practically insoluble problem of compelling all humans at risk to continuously accept and efficiently apply the prescribed and necessary drug dosages under adequate medical supervision. Even in a rigidly totalitarian state the difficulties would still be appreciable.

Therefore mass medication and/or immunization appears to be impracticable as a *primary* method for either control or eradication, although either may be valuable as a supplemental measure.[c]

A third method of attack may be used in diseases where an animal other than man acts as the reservoir of the causative organism. Plague, murine typhus, epidemic virus encephalitis, jungle yellow fever and spotted fever are examples. In some of these diseases, for example jungle yellow fever, control by extirpation of the reservoir animals is impracticable or impossible because of the inaccessibility of the reservoir monkeys. In others, as with virus encephalitis, the reservoir birds are too ubiquitous or migratory for this type of control to be practicable. With plague and murine typhus control has been reasonably successful by improved sanitation in urban areas, which has built out and starved out the rodents and minimized close association of rodents with man. But complete extirpation of rodents in urban areas does not appear to be attainable, and eradication of sylvatic plague by means of extermination of the host rodents appears to be impossible.

In recent years the trend in control measures for plague and murine typhus has usually been toward the use of insecticides to attack the rodent fleas which are the actual disease vectors.

The fourth method of control of a vector-transmitted disease has always been recognized as an applicable control measure; its limitation, until recently, has been the improbability of its effective use with the means available. As the vector must first bite an infective case or carrier, and after a suitable period of development of the causative organism in the vector must then bite an uninfected and susceptible person or animal, it is obvious that if we can prevent the vector from getting in those TWO BITES the transmission of the disease is prevented. To a limited degree house screening and bed nets have done this, but neither cases nor susceptibles will always remain within screen areas or bed nets.

The interruption of the TWO BITES cycle can also be effected by the diversion of vectors from man to non-susceptible animals. This diversion or deviation has had an appreciable effect upon the transmission of malaria, although the effect has not always been understood nor evaluated. Strongly zoophilous species of vectors are easily deviated to animals, but strongly

[c] "Chemotherapy has already proven practicable in several parts of Africa and in the Americas. On the small island of São Francisco (off the Brazilian coast near Santa Catarina) the vectors are *A. cruzii* and *A. bellator* both of which breed in bromeliads and both bite out of doors. Chloroquine has been added to all of the salt destined for the island since 1957 and has proven successful. This method (Pinotti method) is in use in other parts of Brazil and its use is to be extended."—L.L.W.

anthropophilous species are deviated with difficulty. The effectiveness of such deviation therefore depends upon the ecology and host preferences of the vector. With some species which are indifferent in their tastes the presence of numerous domestic animals may have a marked effect in reducing the transmission rate of a disease such as malaria. With strongly zoophilous species the absence of domestic animals may result in disease transmission in humans, but with strongly anthropophilous species the presence of numerous domestic animals may have little effect on the transmission of disease in man. But we should always consider the possibility of animal deviation as an aid in control especially where an animal husbandry can be a useful agricultural practice and a valuable dietary additive.

At the present time there does not appear to be an adequate appreciation of the advantages of animal husbandry, not only as a malaria control measure, but as an economic asset and as an aid to improved nutrition in many areas of the world. In the past it has been responsible, at least in part, for unintended reductions in malaria, and in a few instances has been deliberately used for this purpose. For example, on the Pontine marshes in Italy the farm houses in the 1930's were built with barns attached, and each family was required to keep at least five cows. Leguminous crops, planted for fodder, enriched the soil and the stall fed animals attracted the mosquitoes, because most of the European anophelines are definitely zoophilous.[d, e] The same is true for *quadrimaculatus* and *freeborni* in the United States.

Probably the main reason for the disappearance of malaria in northern Europe has been rotation of crops and manuring to enrich the soil with nitrogen and to stall feed cattle because pasturing usually was not economical. A similar thing appears to be happening in Russia. Hackett and Barber in 1936 (personal communication) found that wherever the Russians had cattle enough most of the anophelines were found in the stables. Given cattle enough, malaria will almost certainly die out in central Russia even if no direct attack is made on the disease.[e]

On the other hand, in China and in most of the Orient there is almost no attempt to combine animal husbandry with agriculture. Here the substitution of animal manures for human excreta in fertilizing would have a great effect in reducing intestinal parasitisms and enteric diseases, and an equally great effect in reducing malaria. In my personal opinion the control (and probably eradication) of malaria in central Honshu (Japan) can be effected by a reasonable increase in the number of cattle. Hackett has noticed recently in parts of our southern states that cotton has been completely replaced by cattle. In such areas malaria has no chance of returning, due to the ecology of *quadrimaculatus*.[e]

ERADICATION BY INSECTICIDES. Since 1945 certain insecticides have become available which have changed the situation by making the interruption of the TWO BITE cycle a practical method. I refer, of course, to the residual effect chemicals such as DDT and dieldrin. Applied to walls and ceilings of human habitations these chemicals kill many insects on contact. With strongly anthropophilous species, and particularly with those which remain within domiciles for a period of time after feeding, the TWO BITE cycle is interrupted. A rapid reduction in the disease rate is obtained, even though no attempt is made to reduce the rate of reproduction of the vectors by attacks upon its larval forms.

If this method is effectively applied in an area, such diseases as malaria can be eradicated in time even though the mosquitoes are still present in appreciable numbers. It has also been possible, as in British Guiana, to exterminate the vector mosquito as well, but more generally we

[d] "You are on dangerous ground in referring to the *maculipennis* complex in Europe. This comprises a number of races and, certainly, some of them such as *labranchiae* and *socharovi* are primarily anthropophilic. *Labranchiae* is the principal vector in Italy where maliria has been eradicated." —L.L.W.

[e] Several of the reviewers disagreed with the statements involving "zooprophylaxis."—Ed.

would expect the end result would be what is termed "anophelism without malaria."

This method, as applied in recent years, has been spectacularly successful in reducing malaria in many regions, and it appears to be possible, providing no interruptions or contingencies occur, that malaria may be extirpated from very large areas, entire countries, and even entire continents.

However, there are certain possibilities and contingencies which may in the long run prevent this desired result. Attention is called to these adverse possibilities, and alternative procedures are suggested below.

Some of the presently foreseeable contingencies are:

1. Insecticide failure
2. Economic breakdown
3. A general, world-wide war

Of these, the failure of the presently available insecticides to maintain their effectiveness against the vectors may be the most immediately important. Many species of mosquitoes and flies have shown an increasing tolerance (resistance) to several of the chlorinated hydrocarbons, such as DDT and dieldrin, and some have shown a tolerance to the organic phosphates such as malathion and parathion. While these tolerances have been most pronounced among the muscid flies and certain *Culex* and *Aedes* mosquitoes, a number of *Anopheles* species also have shown appreciable resistance.

If the present increase of resistance continues that has occurred in the past twelve years, it is possible that in another decade or so none of these insecticides will be effective within rates of application which will be practicable or economically reasonable. And it is doubtful that malaria can be extirpated from the entire world during such a small period of time. If, then, we have depended for the eradication of the disease upon this one method, and if it fails, even if it is only a partial failure, we shall have been defeated in the attempt at the eradication of the disease via this particular method of application of the concept of preventing the vector from getting TWO BITES.[a]

The second contingency unfavorable to the eradication concept is a debacle in the economy in even a few of the major industrial nations. None of us care to face such a possibility but it cannot be ignored, given certain continuing trends in governmental expenditures. This might bring us, if not to a major economic collapse, at least to this dilemma—which comes first, DDT or hydrogen bombs and ICBM missiles? A real tight economic squeeze will almost certainly stop the financial and material aid being given to various disease eradication or control projects in Asia, Africa and South America. In this case diseases such as malaria, yellow fever, plague and cholera could return in epidemic form with very high mortality rates. The concept of eradication will then have been defeated for at least another generation.

A third possibility is a general war. Since 1917 we have been living in one of the major revolutionary periods of history, and the culmination of this period may be a major war. Regardless of which social and economic structure of human society emerges victorious, or even survives, the damage to the social, governmental and economic organization can be expected to be so great that the present concept of eradication will of necessity be abandoned for lack of means, perhaps of will, and perhaps even of lack of knowledge to carry it on to completion. Time will not permit elaboration on this contingency, but it appears to be a definite danger. Certainly the next major war will immediately interrupt the shipment of insecticides to tropical regions, and cause the withdrawal, where and if possible, of the technical staffs supervising the operations.[f]

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[a] Already cited on a previous page.

[f] "History does not bear you out on the effect of wars. During and after World War I the U.S. had its first surge of antimalaria works. Also, during and after World War II its greatest surge, graduating to our eradication campaign. The same is true on a global basis following World War II." —L.L.W.

There are certain other facets of the present eradication concept which may be objectionable for various reasons which I have not heard discussed and which may be briefly mentioned. One of them is the invasion of personal and domiciliary privacy which is involved in the residual spraying of homes. With some cultures this may be a matter of slight resentment, to be accepted passively; in other cultures this invasion of privacy may be resisted or at least resented. It is a fact, however, that up to the present time the men directing the house spraying program have seldom encountered resentment.[g]

One further factor in relation to the eradication concept, by whatever means accomplished, is the requirement that a re-introduction of infection shall be prevented if possible, and if the measures for prevention of such re-introduction fail, the eradication method or methods shall be reactivated until eradication is again accomplished. This facet of the concept appears to be a plausible and a practicable working hypothesis.

Proponents of the eradication concept within its presently used method of reliance on the house residual spray technique [h] claim that this method is the most economical in the long run. It is assumed that the method initially involves larger expenditures of labor and materials than do the so-called "control" methods heretofore used. But when eradication has been accomplished all such expenditures cease, with only a slight outlay being necessary for technical surveillance to watch for possible re-introduction of the disease. The assumption is made that the "control" types of measures involve continuing major expenditures for an indefinite period of time, perhaps unending.[i]

It would appear, however, that the advocates of the present eradication concept have ignored certain factors of importance.[i] These may be set forth seriatim as follows:

1. Some methods which have been used and may be used to control the vectors frequently have considerable economic value. Drainage of agricultural lands is one illustration; the reclamation of swamps for agricultural or industrial use is another;
2. Modification of the environment, whether consciously intended or resulting unconsciously from such modification, has greatly reduced the incidence of certain vectors and their transmitted diseases in a number of areas, and has eventually extirpated them in some areas;
3. While the house residual spray method contributes materially to human comfort *within* dwellings, it may have little effect upon vectors *outside* of dwellings, and in some climates and with some species of vectors it may not be entirely effective, and may not effect out-door comfort. Strongly anthropophilous species which enter houses persistently would be most affected, but other vectors may be little affected by house residual spraying;
4. Some species of anophelines, such as *aquasalis, cruzii* and *bellator,* tend to avoid lethal contact with residual insecticides, which makes this technique of less value against these species;
5. A further problem with this technique is the difficulty in spraying brush huts of primitive people in the jungles of Africa and South America. Lack of time prevents more than its mere mention here, but this difficulty severely limits the applicability of the present eradication concept to two extensive areas of malaria endemicity.[i]

THE NATURAL DECLINE OF SOME COMMUNICABLE DISEASES. Certain things can

[g] "Home-owner resistance to antimalaria or anti-*aegypti* workers has never been a problem."—L.L.W.

[h] See note b, above.

[i] Many workers do not agree that these factors have been ignored in the eradication efforts, but rather, they have been allowed for and utilized in *both* control and eradication efforts which in most cases differ chiefly in scope and administration rather than method.—Ed.

be learned from the natural decline and eventual disappearance of malaria and yellow fever in particular areas.

During the nineteenth century yellow fever declined and died out along the Atlantic seaboard of the United States, although nothing was known as to the method of its transmission until the very end of the century. Severe epidemics occurred early in the century as far north as Halifax in Canada, and in Boston, New Haven, New York, Baltimore and Philadelphia. The reason for this decline, as we now know, was the introduction of public water supplies with piped systems, accompanied by the gradual abandonment, in urban areas, of private wells, cisterns and large water containers such as barrels, which were the favored larval habitats of *Aedes aegypti,* the vector.

This change in environment progressed more slowly in the southern states, and yellow fever continued there for many years, and in New Orleans an epidemic occurred as late as 1905. The effect of the change in method of water supply was accelerated, in urban areas, by the introduction of municipal sewerage systems, which usually followed upon the introduction of public water supplies.[1] These were profound environmental changes which did much to reduce the incidence of other diseases such as typhoid and cholera. But neither the builders nor the users of these facilities, nor the medical profession, realized that they were helping to prevent the transmission of yellow fever. There is also at least an inference that these facilities in a minor degree helped to reduce the prevalence of malaria in cities.

Another illustration is the natural decline and disappearance of malaria in the upper Mississippi Valley (7). As Americans penetrated the Ohio and Mississippi valleys malaria accompanied them, and was for many decades a severe and prevalent infection. But as the homesteaders cleared the forests, ploughed the land and introduced cattle, malaria declined and eventually died out by the early years of the present century. As nothing was known about the method of transmission of the disease until 1898, the cause of the decline must have been environmental changes unfavorable to the effective operation of the principal vectors. In the more southern states there is evidence of a similar natural decline of malaria, although at a much slower pace, and this might eventually have resulted in the elimination of the disease through unfavorable environmental changes.

A similar natural decline of malaria occurred in the central valley of California due to environmental changes (8), but it was accelerated after 1910 by *Anopheles* control measures. Today, even with large populations of one of the vectors (*Anopheles freeborni*) in extensive areas, malaria is extirpated in California, although occasional small outbreaks occur upon the introduction of infected persons from other countries, in special situations (9).

The foregoing examples of the natural decline of malaria and yellow fever admittedly have occurred in what may be termed "fringe areas" of the disease prevalence, or, in the case of malaria, under conditions which G. Macdonald terms "unstable malaria." On the other hand, there is appreciable evidence that even in areas of Macdonald's "stable malaria" relatively simple intended changes in environment have produced valuable results in reducing the prevalence of malaria. Some of the methods of malaria control have been termed "naturalistic" control methods.

These "naturalistic" control methods are of particular value in many tropical regions for the reason that they can be applied with the means available to the native peoples, and by the native peoples, without the importation of mechanical equipment and insecticides.

These brief illustrations of the effects of modification of the environment in controlling a vector-transmitted disease can

[1] "Urban water supplies helped reduce densities of *Aedes aegypti* by reducing breeding places but this mosquito is yet present in sixteen U.S. states. Our real protection from yellow fever was by removing foci of the disease from Havana, Tampico and Veracruz plus a bit of good quarantine work at our ports."—Rev.

be extended to such infections as plague and murine typhus. Modification of the environment obviously has been of great importance in the control of such bacterial infections as typhoid and cholera, and of helminth infestations such as hookworm and ascaris.

Frequently these changes in environment have been made with no thought of disease prevention. Clearing, ground breaking, levelling and drainage for agricultural purposes, and the introduction of animal husbandry, in some instances have had a marked effect in reducing malaria, even though there was no intent or design in these operations for the prevention of malaria. And in an opposite degree, drainage or filling for the prevention of malaria has sometimes resulted in the reclamation of land useful for agriculture or industry.

There have been some situations where environmental changes have contributed to increases in the number of vectors and an increase in disease transmission. These have been situations where the ecologies of the vectors were not understood, or were ignored. Clearing will increase the sun-loving *Anopheles maculatus,* and ditching may be advantageous to *Anopheles minimus.* In contrast, clearing is disadvantageous to *Anopheles umbrosus* and to *Anopheles punctipennis.* Rice-growing usually results in the production of large numbers of *Anopheles hyrcanus sinensis* in China and Japan, or of *Anopheles freeborni* in California. Irrigated pastures will produce large hatches of *Culex tarsalis,* a vector of epidemic virus encephalitis, unless the application of water and the removal of surplus water is properly controlled. Therefore a continuing study of mosquito ecology is necessary to prevent man-made malaria. This list can be extended to other conditions, other vectors and varied environments. But with all vector-transmitted diseases environmental conditions are decisive. And man is the only animal who appreciably modifies his environment.

CONCLUSIONS. It has been the purpose of this discussion to examine the concept of eradication of a vector-transmitted disease (primarily malaria) by the sole means[b] insecticidal attack upon the adult vectors, contrasted with the concept of control, which modification of the environment a basic factor, but where the use of seve methods of attack is envisioned, includi the use of insecticides, according to th applicability under specific conditions.

There appears to be no question, in t case of malaria in tropical areas, that und many situations the house residual spra ing method produces the most rapid duction in the prevalence of the disea But there are several contingencies und which this single and particular meth may fail at some time in the future, wi disastrous results in mortality and mo bidity. We therefore should emphasi also the use of environmental control mea ures wherever applicable.

It is probable the World Health Orga ization will raise the proposed $600,000,0 for the next scheduled five-year mala eradication campaign. This amount money does not appear to be excessive view of the possible results. But it cann exterminate *all* human malaria in *all* t world. In areas with reasonably stab governments and stable agricultural econ mies the eradication of malaria may achieved—say in regions such as Mexi and India. Barring political upheavals may also be attained in the semi-ar regions of the Middle East. But in son Asiatic countries eradication appears to n to be unlikely within the ten years assume to be available before insect resistan builds up to the point where insecticid are ineffective. In China we can be ce tain of nothing. And in the Congo ar Amazon river basins eradication by hou residual spraying is almost certainly n obtainable.

Therefore, it is important to inclu environmental modification technique based on vector ecology, in the prese and future campaigns of eradicatio wherever such environmental chang

[b] See footnote b already cited.

will help to improve the people's economy and nutrition, and in the end lead to a more stable and effective eradication.

References

1. Soper, F. L. 1958. More about malaria eradication. Mosquito News 18(2):55–58.

2. Soper, F. L. and Wilson, D. B. 1943. *Anopheles gambiae* in Brazil, 1930 to 1940. New York: The Rockefeller Foundation.

3. Ross, R. 1910. The prevention of malaria. New York: E. P. Dutton & Co., pp. 153–164.

4. Macdonald, G. 1957. The epidemiology and control of malaria. London: Oxford Univ. Press. Appendix I.

5. Coatney, G. R. Mickelson, O., Burgess, R. W., Young, M. D., and Pirkle, C. I. 1958. Chloroquine and pyrimethamine in salt as a suppressive against sporozoite-induced vivax malaria (Chesson strain). Bull. Wld. Hlth. Org. 19: 53–67.

6. Trop. Med. & Hyg. News 7(6):14–15, Dec. 1958.

7. Ackernecht, E. H. 1945. Malaria in the upper Mississippi valley. Baltimore: The Johns Hopkins Press. Supplement to the Bulletin of the History of Medicine, No. 4.

8. Gray, H. F. and Fontaine, R. E. 1957. A history of malaria in California. Pro. & Papers of the 25th Ann. Conf., California Mosq. Control Assn., pp. 18–37.

9. Brunetti, R. and Fritz, R. F. 1954. An outbreak of malaria in California. Am. Jour. Trop. Med. & Hyg. 3:779–788.

THE BELLEVILLE TRAP FOR QUANTITATIVE SAMPLES OF MOSQUITO LARVAE

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A trap for the sampling of mosquito larvae has been used at Belleville since 1953 and has provided useful and reliable data on population levels of mosquito larvae. Once in position, the trap operates automatically and thus eliminates much of the human error that contributes to the unreliability of the usual dipper techniques (Horsfall, 1946). Its quick operation is more desirable than the slower techniques of capturing larvae by strainers and pipettes from unit areas. The trap can be made cheaply by a tinsmith, and thus has an advantage over a radio-active tagging technique that requires expensive equipment and material (Welch, in press). One person may operate several traps simultaneously and thus increase the number of samples and the accuracy of a population estimate.

This trap incorporates the area sampling principle of Horsfall (1946), a cone similar to that used by Bidlingmayer (1954) for sampling *Mansonia* sp. larvae, and a funnel for concentrating the catch similar to those used in limnological plankton equipment. It has been used for *Aedes* mosquitoes only in pools of the Canadian woodland and tundra areas, but proved useful under these conditions. It could be easily adapted for use in tropical regions.

Construction. The trap consists of four parts; the cylinder, the cone, the concentrator and the bucket (Fig. 1). All are made of galvanized sheet metal except the bucket.

The cylinder is 18 inches high, and 9–13/16 inches in diameter. The metal is rolled near the top and bottom of the cylinder to give it rigidity. The upper edge is flanged, and the lower edge sharpened for ease in pressing the trap into the pool bottom. Two handles are placed on opposite sides of the cylinder. A small flange is fixed inside the cylinder approximately two inches from the lower edge, and a wire screen of one inch mesh may be attached to this to prevent the uptake of detritus, especially moss and leaves, in the trap.

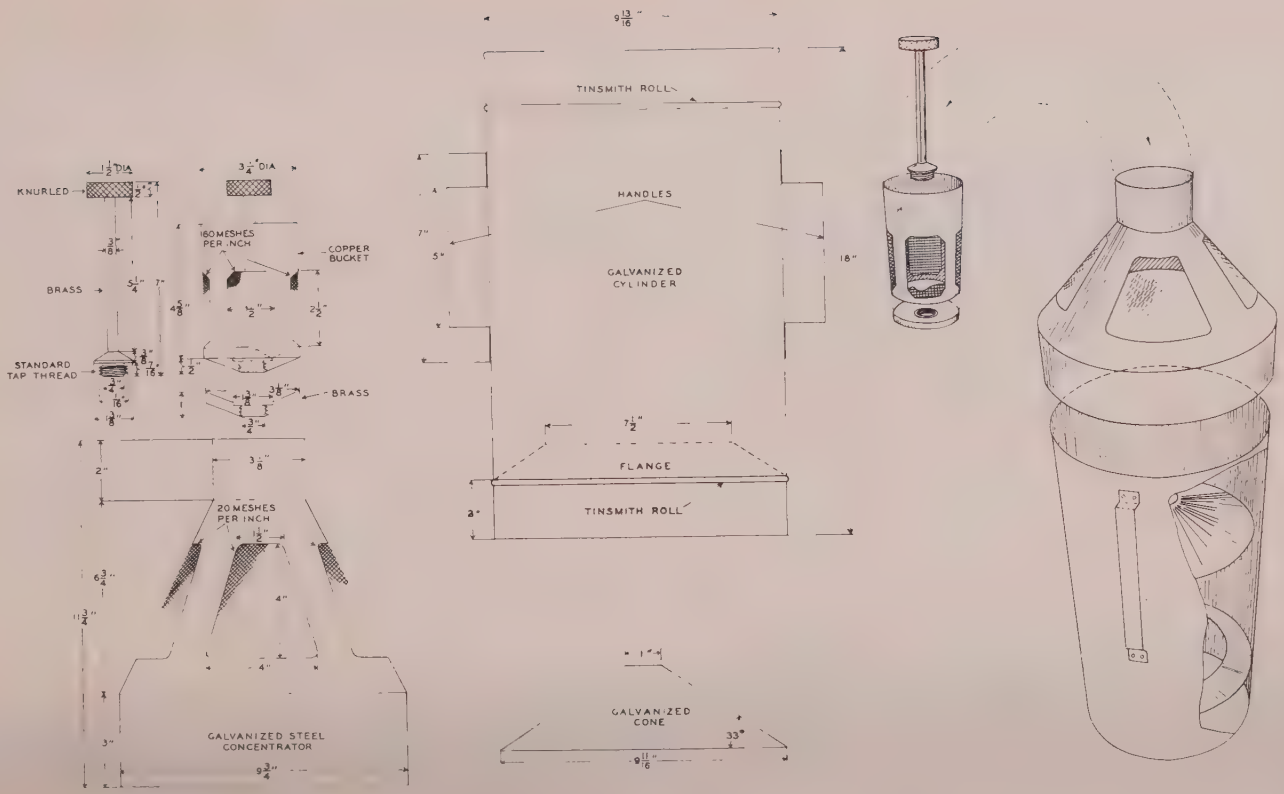

FIG. 1.—The Belleville Trap showing the assembled trap, the cylinder, the cone, the concentrator and the bucket.

The cone has a diameter slightly less than that of the cylinder. The minimum angle of the cone for the operation of the trap against Canadian *Aedes* is 33°, but this might require alteration to permit the capture of other species of mosquitoes. The height of the cone limits the minimum depth at which the trap can be operated. Bidlingmayer's (1954) system of several small cones, if incorporated into the Belleville trap, would probably permit its operation at shallower depths. A hole, one inch in diameter, is cut at the apex of the cone.

The diameter of the bottom of the concentrator is slightly less than that of the cylinder. This end of the concentrator fits into the cylinder in a sleeve-like junction. Four openings are cut in the wall of the concentrator and covered with 20-mesh per inch copper screen. The opening of the concentrator is 3⅛ inches wide.

The bucket is a modified form of the bucket of the Wisconsin plankton net (Welch, 1948). The walls are of copper, while the base and drain plug are of brass. The four openings are covered with 60-mesh copper screen. The diameter of the bucket is slightly larger than that of the top of the concentrator to provide a sleeve junction.

Operation. Most *Aedes, Culex,* and *Anopheles* mosquito larvae dive to the bottom of a pool when disturbed, and then slowly rise to the surface again. This habit is utilized in the operation of the trap. When the cylinder is dropped into position in the pool the mosquitoes dive to and remain at the bottom. A length of cotton dental roll is placed in the flange of the cylinder and provides a tight seal for the cone. A rubber flange fitted to the cone would serve the same purpose. The cone is then dropped into the cylinder (Fig. 2(1)) and sinks until it is seated in the flange at the bottom of the cylinder. The trap is left in this condition for 10 to 20 minutes. The enclosed larvae rise from

Fig. 2.—Operation of the Belleville Trap. (1) Placement of cone; (2) fitting of concentrator; (3) draining trap; (4) removal of sample from bucket.

the bottom, move along the underside of the cone, rise through the opening in the cone, and enter the cylinder.

A cork is inserted in the hole of the cone to produce a better water seal, especially if the samples are taken in shallow water. The bucket is attached to the concentrator, and the concentrator fitted into the top of the cylinder (Fig. 2(2)). The trap is grasped by the handles, lifted, inverted, and allowed to drain (Fig. 2(3)). The bucket is then removed, the plug unscrewed, and the contents drained into a two-ounce jar (Fig. 2(4)). The mosquito larvae may be counted in the field or taken back to the laboratory for examination.

The efficiency of the trap was tested in the laboratory at three larval densities and for three intervals of time. The trap was placed in a large container with a clean sand bottom. A known number of larvae of *Aedes aegypti* (L.) were placed in the cylinder and the cone lowered into position. After a fixed period of time the trap was lifted and the larvae in the trap and the container counted. The following readings are the average and standard error of the number recovered in five replicates for each interval of 5, 10, and 20 minutes respectively at three larval densities: 50 larvae per square foot, 14.4 ± 2.2, 18.6 ± 1.0, 18.6 ± 1.9; 100 larvae per square foot, 34.6 ± 1.8, 37.6 ± 2.5, 36.4 ± 2.6; 200 larvae per square foot, 63.2 ± 7.1, 79.0 ± 3.8, 72.0 ± 3.7. No statistically significant difference was found between the average recovery for each time, though it is obvious that higher recoveries were made at the longer time intervals. The magnitude of the errors appears unrelated to time or larval density. No statistical difference was found in the percentage of recovery when calculated for the nine readings. The percentages show better recovery at 10- and 20-minute intervals than 5 minutes. These percentages, though lower than one might expect, are comparable to those obtained by Bidlingmayer (1954) under similar conditions.

Some larvae are not washed down into the concentrator or bucket, but adhere to the cylinder and the cone. Counts were made during the above tests and the number of larvae remaining in the cylinder was found to be independent of the duration of operation and the number of larvae caught. The percentage of such larvae varied from 1 percent to 20 percent of the total catch. A quick rinse of the cylinder and cone would recover these in the field.

Efficiency in the field could be tested by comparing the catch in the cylinder and cone for a specific period with the catch in the cylinder for a 24-hour period without the cone in position.

The most practical operation of the trap involves the use of 10 cylinders and cones and one concentrator and bucket. The cylinders are set out in a series. When the last trap is set in position, the first trap is ready to lift and to collect mosquito larvae.

As the area of the cylinder is a constant, the number of larvae caught may be used as a measurement of density. Several catches from one pool may be totalled to give the average number per unit area. Determination of the pool population may be made by multiplying the pool area by the unit density.

References

BIDLINGMAYER, W. L. 1954. Description of a trap for *Mansonia* larvae. Mosquito News 14:55.

HORSFALL, W. R. 1946. Area sampling of populations of larval mosquitoes in rice fields. Ent. News 57:242.

WELCH, H. E. 1960. Two applications of a method of determining the error of population estimates of mosquito larvae by the mark and recapture technique. Ecol., in press.

WELCH, P. S. 1948. Limnological Methods, Philadelphia, U.S.A., 381 pp.

SIMPLIFIED METHOD FOR MAINTAINING *CULEX PIPIENS* LINNAEUS IN THE LABORATORY (DIPTERA: CULICIDAE)

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When a laboratory colony of *Aedes aegypti* is not being used for experimental purposes, it can be preserved for about six months by storing the eggs, after appropriate conditioning that involves drying (Shannon and Putnam, 1934). On the other hand, the eggs of *Culex pipiens* will not withstand drying, and the colony must be reared continuously even when it is not in use. The larvae are usually reared in trays, and this involves the expenditure of considerable time and labor in measuring out rearing media, transferring pupae to cages, harvesting of eggs, and cleaning utensils. For some years this laboratory has had a colony of *C. pipiens;* at first the colony was reared by the usual method, but in 1954 I began attempts to find a less time-consuming procedure for maintaining this species. The following procedure was in use at the end of 1955, but the colony was destroyed early in 1956. Our present colony was established in October, 1957, and from the start has been maintained continuously by the method that follows.

All stages of the mosquito are kept in one cage. The only labor is in adding larval food to the dishes three times a week, replacing the rearing dishes for the larvae once or twice a year, placing a chicken in the cage twice a week as a source of blood for the females, and keeping two small bottles of sugar solution in the cage.

Our rearing room is maintained with a relative humidity of 75 to 80 percent and a temperature of 70° to 72° F. These temperatures are below the optimum for *C. pipiens,* but we are obliged to use them because *Culiseta inornata* is reared in the same room, and its temperature optimum is near 68° F.; both species survive well at the compromise temperatures. The light in the room is controlled automatically to give an artificial daytime of 17 hours and a six-hour period of darkness preceded by a half-hour sunset period and followed by a half-hour sunrise period. *C. pipiens* swarms and mates in the cage during the sunset and sunrise periods.

The cage containing the colony is 2 x 2 x 2 feet with screen on two sides, back, and top, and a "Masonite" bottom; the front is of quarter-inch "Plexiglas" in a wooden frame hinged at the top. A cotton sleeve, eight and one-half inches in diameter, is inserted in the center of the Plexiglas panel. The floor of the cage is covered with green blotting paper.

Two pyrex crystallizing dishes, 190 mm. in diameter and 100 mm. deep, each containing about 1500 ml. of Bates' "Medium S" (Bates, 1941), are placed in the cage for the eggs, larvae, and pupae. On the day that the dishes are prepared, the level of the surface of the medium in each dish is marked with a grease pencil on the outside of the dish, and this level is maintained by the addition of distilled water when necessary. In addition to the Bates' Medium, each dish is started with 100 mg. dry "Difco" Brain Heart Infusion; 50 mg. dry, powdered baker's yeast; and 240 mg. dry, powdered, whole wheat bread crumbs. Three times a week thereafter, 50 mg. of the yeast and 240 mg. of the bread are added to each dish. The bread crumbs are prepared by drying slices of whole wheat bread in an oven at 40° C. for several days then passing the dried bread through a grinder with a 40-mesh (.025 inch) sieve. The yeast is "Fleischmann's, Active Dry" passed through a

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grinder with a 60-mesh (.016 inch) sieve. A continuous stream of compressed air is bubbled slowly through the medium in each dish to prevent formation of a scum that would smother the larvae and pupae.

The females deposit their egg rafts on the surface of the medium during the period of darkness. The eggs hatch and the larvae and pupae complete their development in the dishes. The dishes appear to be crowded, but this apparently does not harm the colony other than to give a greater variation and smaller mean size in the adults. One hundred dead females picked at random from the bottom of the cage had a maximum wing length of 4.4 mm., a minimum of 3.2 mm. and a mean length of 3.8 ± 0.02 mm.[2] One hundred females reared in trays containing 250 larvae in 2½ litres of medium had a maximum wing length of 4.3 mm., a minimum of 3.9 mm. and a mean length of 4.0 ± 0.003 mm. The probability of this difference in the means occurring by chance was less than 1/1000 so it seems safe to assume that the method here recommended for maintaining the colony produces smaller and less uniform adults. In the tray-reared specimens, only four percent of the larvae died, one percent of the pupae, and the ratio of males to females in the emerged adults was 1:1.06.

In time, a sediment forms at the bottom of the dishes and occasionally the surface of the medium has to be skimmed with filter paper if a mold begins to form on the floating debris. One dish has been left in the cage for a year and when removed was still teeming with larvae and pupae. Usually the dishes are changed every six or nine months, for aesthetic reasons.

Two 30-ml. serum bottles with wicks of absorbent dental rolls and containing 10 percent sucrose solution are kept in the cage for the adults. A chicken in a restraining cage is placed inside the mosquito cage twice a week to provide the females with blood. The chicken is placed in the cage at 9:00 a.m. and removed at 4:30 p.m., and, because *C. pipiens* feed more readily in the dark, the mosquito cage is covered with a black cotton shroud while the chicken is in the cage; this also serves to keep the chicken quiet. The blotting paper on the floor of the cage is replaced from time to time when it becomes heavily soiled with dead mosquitoes and feces.

In the above method, all stages are present in the cage at the same time, and, so long as withdrawals are not too great, the colony, without further modification, can provide material for experimental purposes. If greater numbers, or larger and more uniform specimens are required, eggs can be removed from the cage for tray rearing.

Our present colony of *C. pipiens* has been maintained in one cage for 20 months. The colony was started from hibernating females from Guelph, Ontario, which were placed in the cage when the temperature of the rearing room ranged from 74° to 79° F. and relative humidity and light were as above. The first blood meal was taken 10 days after the mosquitoes were brought into the laboratory, the first eggs were laid three days after the first blood meal, and adults began to emerge 11 days after the first eggs were laid. The temperature was gradually lowered later to accommodate the *Culiseta inornata,* and it is estimated that the time from egg to egg for the *C. pipiens* in the cage is now about 25 days. No evidence of autogeny has yet been found in our strain of *C. pipiens,* it is homodynamous and, judging from the frequency with which my hand has been bitten, it is anthropophilous as well as ornithophilous.

It should be noted that we have not yet been successful in adapting *C. inornata* to this method of rearing. The larvae of this species cannot develop in as wide a range of habitats as *C. pipiens,* and mortality among the larvae is always high after the first generation in the cage. On the other hand, *Aedes aegypti* thrives in the cage when a guinea pig supplies the blood instead of a chicken, and it is not necessary to shroud the cage when the guinea pig

[2] Mean ± standard error.

is present. *A. aegypti* females lay their eggs on the surfaces of the media in the dishes and around the insides of the dishes just above the level of the surfaces of the media. To collect the eggs of this species, it is only necessary to hang strips of paper toweling down the inside wall of a dish with the bottom edges of the papers dipping into the medium.

It is likely that other stenogamous species with larvae that can tolerate a wide range of habitats could also be reared by this method.

Summary. A method, requiring a minimum of time and labor, is described for maintaining a colony of *Culex pipiens* in the laboratory. All stages of the mosquito are kept in one cage, and the only attention required is the addition of larval food three times a week, provision of a blood meal for the females twice a week, and occasional cleaning of the cage and replacement of the two larval dishes. The adults are less uniform in size and have a smaller mean size than those produced from tray-reared larvae, but the colony appears to be vigorous and has been providing material for experimental purposes for almost two years.

References

Bates, M. 1941. Studies in the technique of raising anopheline larvae. Amer. Jour. Trop. Med. 21:103–122.

Shannon, R. C., and Putnam, P. 1934. The biology of *Stegomyia* under laboratory conditions: I. The analysis of factors which influence larval development. Proc. Ent. Soc. Wash. 36:185–216.

NOTES ON THE CHEMICAL CONDITIONS IN THE MOSQUITO LARVAL ENVIRONMENT

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The first oil field in Nebraska was developed in Richardson County in 1940. In the ensuing years large amounts of saline water were pumped with the oil. The oil and water form an emulsion which is separated by a demulsifying agent into a two-component system. De Groote (1948) has described in detail the commercial chemical demulsification process.

In the Richardson County oil field, no provision was made to dispose of the saline water resulting from the desalting process and it was allowed to drain to the nearest available low area where it formed ponds or marshes.

In recent years the wells in Richardson County have been pumped only several days a week with the result that there has not been enough water to form well defined ponds; instead, there have been formed small marshy areas with an aquatic flora of cattails, sedges, rushes, smartweed and arrowhead.

During routine mosquito surveys it was found that these marshes were supporting a fair population of mosquito larvae. The principal species found were *Culex restuans, Culex tarsalis, Anopheles punctipennis* and, after heavy rains, *Aedes vexans*.

Two marshes formed by the effluent of demulsification plants were studied, one located 3.3 miles south of the Village of Barada and the other 4.5 miles south of the Village of Dawson. As a control, a spring-fed pond and marsh located at Preston Corner approximately a mile north of the Village of Preston was also studied.

From January until December the areas were visited monthly and gallon samples of water were taken. Dipping for mosquitoes was done during the mosquito season. At Dawson, the oil well and

separator were in use only from February until May so that only four months' data are used. During January and February the Preston pond and marsh was dry due to an extremely dry fall.

All three areas were producing the same mosquito species; yet, the chemical composition of the water from the marshes, oil separators, and natural spring-fed pond, varied greatly. Table 1 is a summary of the chemical analysis of the three areas expressed in parts per million.

The demulsifying agents used to separate the oil and water are organic compounds. De Groote's study shows they combine with the oil rather than water; therefore, it can be assumed that the increase in mineral content found in the Barada and Preston waters is due to the high mineral content of the oil well brine.

Although much has been written about the larval environment, only a little amount of work has been done on the chemical make-up of the environment.

Bates (1949) states: "Many studies have been made of the hydrogen-ion concentration in mosquito breeding places, partly because pH is an important factor in many biological processes, but also partly because it is the most easily measured of the physicochemical factors of the aquatic habitat." Wigglesworth (1942) demonstrated in the laboratory that variation in pH had no ill effect upon larval development. The field results reported in this study agree with Wigglesworth's study and also with that of Kirkpatrick (1925) who found no correlation between pH and species of mosquito.

What effect the total solids in the water has on mosquito production is difficult to determine from this study. It is interesting to note that the water at Barada and Dawson has over 90 percent more solids than the naturally occurring water at Preston.

TABLE 1.—Chemical composition (ppm) of larval environments

	Barada	Dawson	Preston
pH	8.2	7.6	7.4
Total Solids	3973.0	7652.0	391.0
Total Alkalinity	303.0	266.0	128.0
Chlorides	1392.0	2499.0	7.9
Sulphates	880.0	1900.0	53.0
Potassium	33.0	38.0	7.3
Sodium	1248.0	2098.0	11.0
Calcium	60.0	347.0	41.0
Magnesium	32.0	81.0	16.0

Since in coastal areas there is a marked difference between the mosquito faunas of fresh and brackish water, the relationship of salinity tolerance of larvae has been studied by several workers. It will be noted that the water at Barada has 176 times more chlorides and the water at Dawson has 316 times more chlorides than the naturally occurring water at Preston. There is also a very marked increase in the sulphates and in the sodium content.

From the studies of Beadle (1939) and Wigglesworth (1950), there appears to be some mechanism which controls the regulation of osmotic pressure in the haemolymph of mosquitoes which live in water with a high salt concentration.

CONCLUSIONS. It would appear that larvae of *Anopheles punctipennis, Culex restuans, Culex tarsalis,* and *Aedes vexans,* are not affected by high concentrations of inorganic salts. This study agrees with Kirkpatrick's (1925) Egyptian study which showed that: "The differences among mosquito species in the upper limit of salt tolerance may be great, but that relatively few of any species are strictly confined to waters of high salinity." Thus it would appear that oil well brine seepage pits are just as suitable larval habitats as naturally occurring ponds and marshes.

Bibliography

BATES, M. 1949. The Natural History of Mosquitoes. New York: Macmillan, 379 pp.

BEADLE, L. C. 1939. Regulation of the haemolymph in the saline water mosquito larvae *Aedes detritus.* J. Exp. Biol. 16:346–362.

DE GROOTE, MELVIN. 1948. Chemical demulsification in the petroleum industry. Ohio State U. Eng. Exp. Station 20:13–20.

KIRKPATRICK, T. W. 1925. The Mosquitoes of Egypt. Cairo, Government Press. 224 pp.

WIGGLESWORTH, V. B. 1942. The storage of fat, glycogen, and uric acid in the fat body and other tissues of mosquito larvae. J. Exp. Biol. 19:56–77.

———. 1950. The Principles of Insect Physiology. London, Methuen, 544 pp.

TWO-WAY RADIO AIDS MOSQUITO ABATEMENT DISTRICT

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In California's agricultural empire, "The Great Central Valley," mosquito control, for various reasons, is, and has been for years, basically a larviciding operation. With this approach to mosquito control, it is most essential that large regions be under constant surveillance.

Where timing and speed of insecticide applications are most important in attaining desired results, two-way radio communication has proved exceptionally valuable. A Motorola two-way system, with eight mobile units, was placed in operation by the Kern District in July of 1957, and has since been used in all facets of our operation. We found the original eight units so helpful and valuable that four additional units have been added since 1957.

Two-way radio is used at Headquarters' office and in the following equipment:

Pick-up trucks of five division foremen (Fig. 1).

Two pick-up trucks and a truck in the Source Reduction unit.

Mechanic's pick-up truck.

District Airplane (Fig. 1, *insert.*)

Manager's and Entomologist's cars.

The District operations cover in excess of 1300 square miles, ranging a distance approximately 100 miles from one end to the other. Most of this area requires constant surveillance and inspection every few days. To provide repetitive inspections

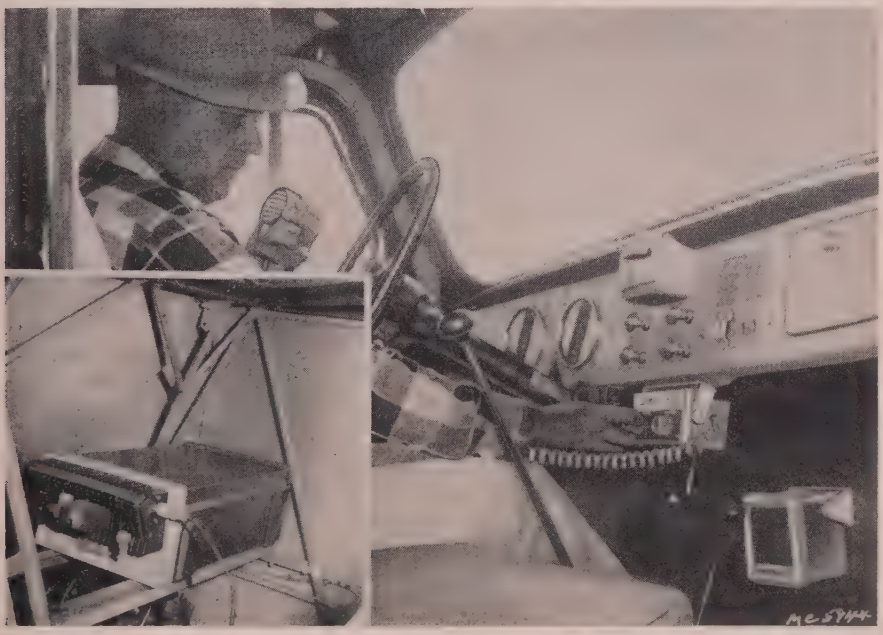

Fig. 1.—Foreman adjusts squelch on mobile two-way radio while receiving message from headquarters. *Insert:* The compactness of the transmitter-receiver makes it simple to mount in plane.

and insecticide treatments over such a large area, the District is divided into five divisions, four rural and one urban, which includes Bakersfield and other principal cities in Kern County. A foreman provided with a radio-equipped pick-up is in charge of each division. He directs the operations of five to six patrolling inspector-operators in jeeps which contain necessary spraying equipment. The two-way radio system has been especially helpful to management in integrating the widespread operations and keeping all key personnel in constant touch with current problems.

Our Motorola system offers many advantages. In addition to keeping us in touch with current problems so that we can keep ahead of developing mosquitoes, two-way radio aids us to:

1. Cut mileage and the expenses of travelling.
2. Cut the number of man hours required to do our work.
3. Secure fast aid in breakdowns.
4. Reduce the number of vehicles needed.
5. Keep tabs on locations of all men and equipment, as well as shift men and material immediately when needed.
6. Improve public relations

Radio's first benefit listed—mileage reduction—is illustrated in several ways. For one example, when an operator's jeep becomes embedded, he can usually reach a telephone within a reasonable distance and call headquarters. Headquarters will contact the division foreman by radio. Quite frequently the foreman is only a few miles away and can quickly come to the aid of the immobilized jeep. Without radio, all too often, we would be forced to send aid from our headquarters, which may be 50 miles or so away. In such cases, it was heretofore not uncommon for two men to lose one-half day each to get the equipment out and running.

Radios help us reduce travel, save time, and increase efficiency in the operation of our plane. When a foreman discovers a critical situation where emergency treatment is required, he radios the pilot. The pilot sprays the area as he comes to it during the course of the day. Radio has saved the pilot from landing his craft, getting the additional assignment and going back to the critical area. The foreman is saved time and miles which would be required in locating and contacting the plane on the ground.

In general, we reduce mileage in every instance where we can contact key people by radio rather than being forced to locate them by travel or wait until they have checked in, then sending them back to do a particular job.

A reduction in man hours is another benefit of radio. With the Motorola system, we attain maximum utilization of our men because we are able to dispatch them to areas requiring immediate attention.

Because of radio, we do not have to put another man in the shop. Our mechanic can handle all repairs by himself through close coordination with the various foremen. Many times a foreman in the field "gets on the radio" and describes vehicle trouble to the mechanic in the shop. The mechanic can frequently diagnose the problem and radio back instructions, enabling the foreman to make necessary repairs without coming in to the shop.

While out on a service assignment, the mechanic monitors his radio for additional repair calls. As they come in he makes the added stops along his route before returning to the shop. Radio has prevented a second trip to and from the original area of servicing. Here another benefit of radio is realized—fast aid in breakdowns.

The effective use of our plane, coordinated with radio, is a major aid in minimizing the number of men required to carry out our activities.

Our two-way radio system makes possible the performance of our assignments with a lesser number of vehicles. If we could not coordinate spraying as closely as we do with radio, we would probably have to add three zones to our present set-up. This would mean the addition of three men and three jeeps, which would increase costs.

We are able to keep close control over our equipment and men with radio—the fifth benefit listed. Heavy equipment, such as dozers, are expensive to operate, so maximum utilization must be achieved. Through our equipment operator, who has a radio in his vehicle, we can make up a tight schedule so that all equipment is used to the fullest.

Also, many times a foreman needs a certain piece of equipment in a hurry, so he simply radios for it. If he did not have radio, he would be forced to leave the job in order to go to a telephone to make his request. Headquarters would then hunt down the equipment and send it out. Much valuable time and many man hours would be lost.

Public relations are improved through radio. Service to a home owner is possible minutes after a call for aid is received. The dispatcher simply takes the call, radios the foreman, who may be only a few blocks away. Frequently he will answer service requests within minutes of their being received in the office.

Besides the benefits mentioned here, radio is a big boost to the source reduction men who are frequently in their vehicles, contacting persons in seeking to eliminate mosquito producing sources. When service requests come in while the men are on the road, the dispatcher simply relays the request and the source reduction men make the additional stops as they come along their routes. The two source reduction men also use radio to keep in touch with the foremen in the event a troublesome problem is encountered.

Our radio system has four control points at headquarters, any one of which may be used to contact the men in their vehicles. Each control point consists of a handset and loudspeaker. Phones are located at the office secretary's desk, the manager's desk, in the office of the Entomologist and in the mechanic's shop. The Motorola base station is located at headquarters, and the repeater station on nearby Mt. Breckenridge, at an elevation of 7600 feet. The system is part of the countywide radio system of Kern County, and all maintenance is handled by the county. The system is licensed on the UHF band.

The two-way radio system has proved so valuable as an aid to us in our mosquito control operations that its increased use will be included in any plans to expand our abatement activities.

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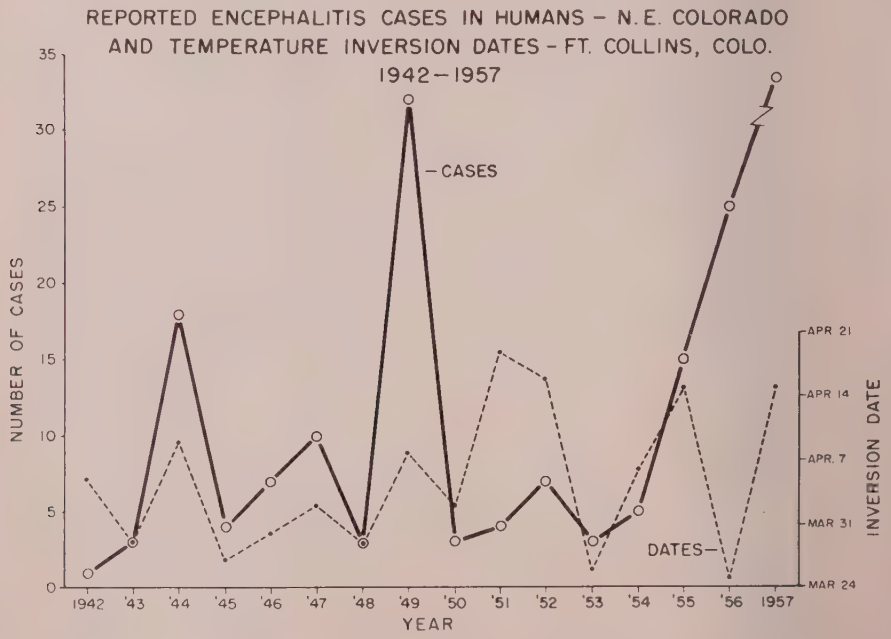
A NOTE ON REPORTED CASES OF ENCEPHALITIS AND SOIL TEMPERATURES IN COLORADO[1]

E. E. BENNINGTON AND IDA L. SHERMAN

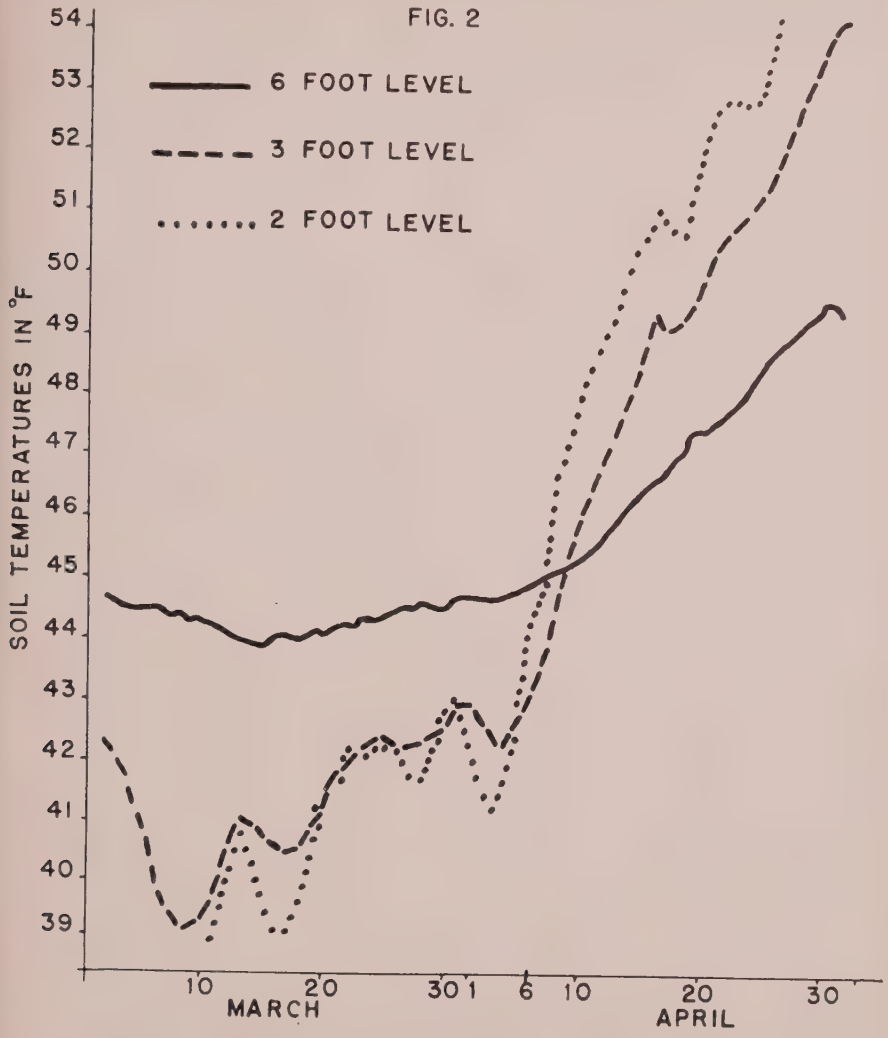
A possible relationship between encephalitis virus activity and the date of the spring soil temperature inversion may provide the earliest seasonal indication of a potential increase in the mosquito-borne virus. This interesting association may be seen in Figure 1 which shows spring soil inversion dates and the number of reported cases of encephalitis in eastern Colorado for a period of sixteen years, 1942–1957.

FIG. 1



The inversion date (Fig. 2) marks the temperature change of the surface soil from colder, to warmer than the subsoil, and in the Colorado area denotes the beginning of the *tarsalis* season, since *Culex tarsalis* emerges from hibernation immediately after this date (Bennington, Blackmore and Sooter, 1958). This temperature inversion is not clear-cut in some years, i.e., 1944, 1945, and 1953 as shown in Table 2, there being a return to winter soil temperatures and a second or rarely a third inversion. When more than one inversion occurs, it is impossible, with the data now available, to determine which date marks *Culex tarsalis* emergence; therefore the date of the first inversion (Table 2) was arbitrarily chosen for Figures 2 and 3.

[1] United States Department of Health, Education and Welfare, Public Health Service, Bureau of State Services, Communicable Disease Center, Atlanta, Georgia.



A SOIL TEMPERATURE INVERSION WHICH OCCURRED AT FT. COLLINS, COLORADO, MARCH 6, 1954

TABLE 1.—Reported cases and deaths of encephalitis
Northeastern counties of Colorado

County	1942		1943		1944		1945		1946		1947		1948		1949		1950		1951		1952		1953		1954		1955		1956	
	C	D	C	D	C	D	C	D	C	D	C	D	C	D	C	D	C	D	C	D	C	D	C	D	C	D	C	D	C	D
Adams					1	—									2	1					1	—	—	1	2	—	4	2	6	—
Arapahoe			1	—	2	—					2	1			7	1	1	—	1	—	2	—					3	1	4	—
Cheyenne																														
Denver					3	—	2	—	3	—			—	(1)	1	(7)			—	(2)	1	(2)	—	2			5	1	10	1
Douglas																														
Elbert											1	—																		
Kit Carson															1	—									1	—	1	—	2	—
Lincoln																														
Logan	—	(1)							1	—					2	2														
Morgan					—	(1)					1	—	1	(2)	2	—			1	—	1	—					1	—		
Philips																									—	(1)	1	—		
Sedwick					1	1					2	—			1	—														
Washington															3	—														
Weld			2	—	10	—	2	—	3	—	3	—			6	1	2	1			—	(1)			1	—			1	—
Yama											1	—			1	—													2	—
	—	1	3	—	17	2	4	—	7	—	10	1	1	3	26	12	3	1	2	2	5	3	—	3	4	1	15	4	25	1
Deaths not reported as cases (figures in parentheses)					1								2		6				2		2				1					
Total	1		3		18		4		7		10		3		32		3		4		7	3			5		15		25	

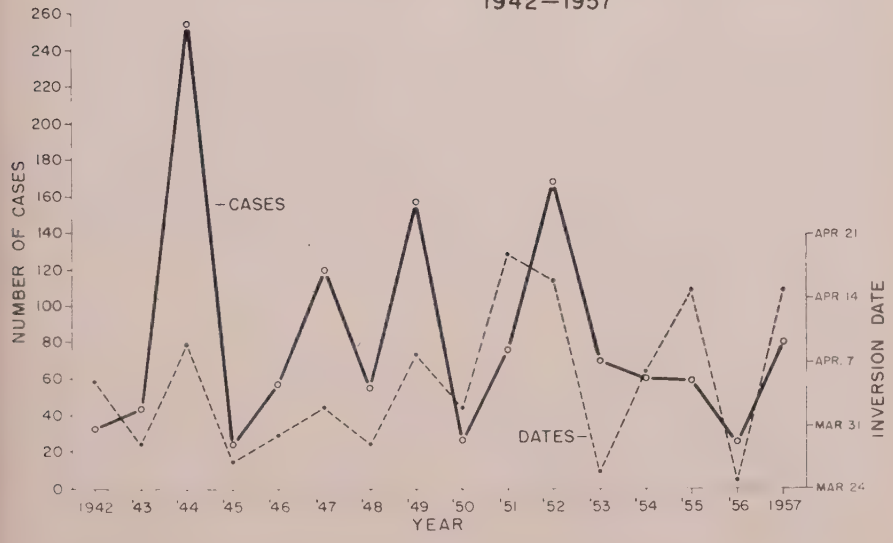
Source of data: 1942–1946, National Office of Vital Statistics; 1957—a total of 133 cases were confirmed by laboratory test with onsets in 1957. Personal communication, Dr. Luther Giddings, Greeley Field Station, Communicable Disease Center.

TABLE 2

Year	Ft. Collins inversion[1] date	Number human cases[2] Eastern Colorado encephalitis	Number equine cases[3] Colorado state	Horse population in affected areas	Rate per 1,000 horses
1942	April 5	1	33	90,414	0.4
1943	March 29	3	44	58,787	0.7
1944	April 9 (27)	18	255	103,544	2.5
1945	Mar. 27 (Apr.9)	4	24	79,623	0.3
1946	March 30	7	57	62,247	0.8
1947	April 2	10	120	87,008	1.4
1948	March 29	3	45	61,477	0.7
1949	April 8	32	157	86,111	1.8
1950	April 2	3	26	56,505	0.5
1951	April 19	4	76	49,938	1.5
1952	April 16	7	168	58,289	2.9
1953	Mar. 26 (Apr. 27)	3	70	15,796	4.4
1954	April 6	5	60	13,565	4.4
1955	April 15	15	59	25,517	2.3
1956	March 25	25	25	23,128	1.1
1957	April 15	N.A.	80	32,324	2.5

[1] Alternative dates (figures in parentheses) omitted in graphs.
[2] Summary line from Table 1.
[3] Source of data: U.S.D.A., Agricultural Research Service.

Fig. 3: REPORTED ENCEPHALITIS CASES IN EQUINES — COLORADO AND TEMPERATURE INVERSION DATES — FT. COLLINS, COLO. 1942—1957



The median date of the temperature inversion at Ft. Collins, Colorado, for the past sixteen years is April 5, ranging from March 25 to April 19, with two-thirds of the dates extending from March 27–April 15.

The inversion date is one of a number of environmental and climatological indices used in the control of various predatory agricultural insects. Wheat growers consult their county agricultural agents for weather data on safe sowing dates to reduce Hessian fly damage; bean growers obtain planting dates, which vary from year to year (Baker and Mathews, 1952), to avoid the seed corn maggot. A migration of white grubs follows the spring soil temperature inversion, and the date of this phenomenon provides a timing (McColloch and Hayes, 1923) for one method of control of these larvae.

Although the diagnosis of encephalitis is difficult and the reported case and death data may reflect entities other than encephalitis, or the reported data may be deficient as an indicator of the number of cases occurring in a given locality, such data as are available on this disease are shown in Table 1 for 15 northeastern Colorado counties. Table 2 shows the inversion dates and the reported human cases on which Figure 1 is based. The incidence of cases of encephalitis appears to vary in accordance with the change in the inversion date, i.e., more cases when the inversion date is late in the spring, fewer cases when the date is early. The number of cases, however, is not directly proportional to the difference in days between inversion dates of successive years. And in one instance there was an inverse relationship: in 1956 the cross-over in temperatures occurred early, but the number of encephalitis cases reported was considerably larger than in the preceding year.[2] However, the general concordance between reported cases and annual fluctuation in spring soil inversion dates is of interest; especially so, since there is the suggestion that a shorter *tarsalis* season apparently has a greater potentiality of virus activity than a long season which begins earlier in spring.

Fig. 3 shows the trend of inversion dates at Ft. Collins, Colorado. The reported horse (and/or mule) cases of encephalitis are given in Table 2 for the entire state of Colorado. The same general conclusion may be drawn from this graph: when the inversion date occurs late in the spring, more horse encephalitis cases were reported.

The date of soil temperature inversion appears to be related to the human and horse cases of encephalitis which occur later in the summer and early fall. There is an interval of time between the date of inversion and the "encephalitis season" of at least two months when other ecologic factors are contributing to a mosquito-virus build-up. The mechanism whereby a virus build-up is produced when the *tarsalis* season is reduced remains to be explored.

Soil temperatures can be taken by means of inexpensive thermistors or thermometers buried in the soil at depths of 1, 3 and 6 feet; and such data are already being recorded by some Agricultural Experiment Stations and United States Weather Bureau Stations. For a selected locale, these data and the index of mosquito population maintained by the local mosquito abatement service may provide a clue in spring to the later seasonal activity of mosquito-borne encephalitis viruses.

[2] The number of cases in 1953 was larger than any other year in the period studied. For this year two inversions occurred—one very early and one very late.

References

BENNINGTON, E. E., BLACKMORE, J. S. and SOOTER, C. A. 1958. Soil temperature and the emergence of *Culex tarsalis* from hibernation. Mosquito News 18:297–298.

BAKER, W. A. and MATHEWS, O. R. 1952. Good farming helps control insects. In the Yearbook of Agriculture, Supt. of Documents, Washington, D. C., pp. 437–440.

MCCOLLOCH, J. W. and HAYES, W. P. 1923. Soil temperature and its influence on white grub activities. Ecology 4:29–36.

A PRELIMINARY STUDY OF THE BLOODSUCKING DIPTERA ON CAPE COD, MASSACHUSETTS

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Cape Cod Mosquito Control Project

The extensive salt marsh and fresh water habitats on Cape Cod are known to produce a variety of bloodsucking insects that attack man and animals. The majority of these pests belong to the families Tabanidae (horse flies, greenheads and deer flies), Heleidae (gnats, punkies or sand flies) and Culicidae (mosquitoes) of the order Diptera.

The purpose of our investigations conducted during the summer of 1958, was twofold: (1) to acquire general information relative to the breeding areas, distribution and comparative abundance of the various bloodsucking Diptera on Cape Cod; and (2) to utilize this information as a basis for the formulation of control measures. Since much active work was already in. progress on mosquito control, the emphasis in our study was directed toward the nuisance species belonging to the Tabanidae and Heleidae.

TABANIDAE

Four species of tabanids are known to breed commonly in salt marsh sod along the Atlantic seaboard (Pechuman 1957, Wall and Jamnback 1957). These are *Tabanus lineola* Fab., *T. nigrovittatus* Macquart, *Chrysops atlantica* Pech. and *C. fuliginosa* Wied. Of these, *T. nigrovittatus,* the greenhead fly, is considered to be the most serious pest of man.

Sampling for Adults

Materials and Methods. In order to determine the relative abundance, distribution and emergence peak of the salt-marsh tabanids, traps were placed in 31 principal marsh areas on Cape Cod. The traps consisted of a vertical square foot of masonite mounted on a stake and daubed with a slow drying adhesive, "Tanglefoot." Hansens (1952) successfully used this procedure in New Jersey, although "Deadline" was employed as the adhesive material. At each test site two traps were placed back to back facing east and west, and two others similarly placed facing north and south. The height of the traps above ground level was approximately 1 to 2 feet so that the masonite was just above the top of the marsh grass. This was found to be the most effective height to trap the migrating adults (Jamnback and Wall, 1959).

Counts were made weekly beginning on June 23 and ending on September 8. The flies entrapped in the sticky material were removed with forceps during each count and the trap was then resmeared. More frequent observations were made on a limited number of traps during the entire summer.

Results and Discussion. Our catch included the four species previously mentioned as well as a number of *T. lasiophthalmus* Macquart and a few *C. carbonaria* Walker. In fact, the *Tabanus* counts recorded from June 23–July 7 were almost exclusively *T. lasiophthalmus.* From July 7 to September 8, *T. nigrovittatus* was found to be the principal species of *Tabanus* occurring on the traps, although a few *T. lineola* were also noted. From the initial counts on June 23 until July 7, *C. fuliginosa* was found in large numbers in certain of the marshes. By June 14, the last few *C. fuliginosa* and the first few *C. atlantica* were recorded on the traps. This latter species persisted throughout the summer, but in relatively small numbers. The data compiled from greenhead counts made on the adult traps located in marsh areas that remained unsprayed throughout the summer are shown in Figure 1.

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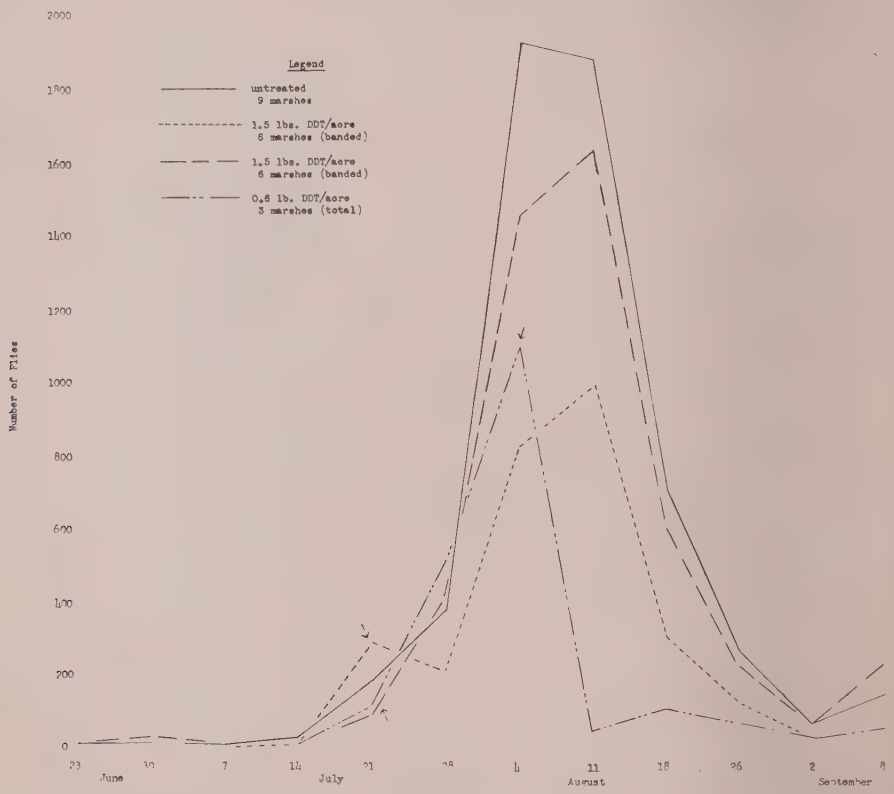

FIG. 1.—A comparison of greenhead fly counts from adult traps located in treated and untreated salt marsh on Cape Cod, 1958. Arrows indicate the dates of spray application.

The typical greenhead emergence pattern of: (1) the rapid increase of adult population; (2) the period of peak population; and (3) the sudden decrease in fly population is quite apparent. A similar pattern of fly emergence was obtained by Gerry (1950a) from studies made on the North Shore in Massachusetts, by Hansens (1952) in New Jersey and by Jamnback and Wall (1959) on Long Island. It may also be noted that the emergence peak did not occur until the first week in August which is approximately 2 to 3 weeks later than the emergence peaks found by these investigators. However, it is our opinion that this delay in adult emergence was primarily due to the cold rainy weather that prevailed on Cape Cod during the spring and early summer of 1958.

CONTROL OF ADULTS

For the past two years a coordinated program of greenhead fly control has been carried out in all the towns on Cape Cod. Each town contributed its proportional share of money to finance the cost and application of the insecticide while the Cape Cod Mosquito Control Project coordinated and carried out the program. The program consisted of applying a DDT-oil spray to the inner (upland) margins of the salt marsh as recommended by Gerry (1950a, 1950b).

MATERIALS AND METHODS. To determine

if such a program caused a marked reduction in greenhead populations, it was decided to utilize the trap sites already available as a means of sampling the adult greenheads in treated and untreated areas. Nine marshes were left untreated throughout the summer to serve as control areas. Six marshes were "banded" on the upland margins on July 19, 20, and 21 and six others were treated in a similar manner on July 22 and 23. It was impossible to spray all the marshes on one given date because of inclement weather, the extent of the marsh area and the availability of only one helicopter. The spray application was put on by helicopter and consisted of 12 percent DDT in fuel oil applied in a swath about 100 feet wide at the rate of 1.5 pounds of actual DDT per acre. On August 4, three more marshes were treated with 5 percent DDT in fuel oil applied at the rate of 0.6 pound of actual DDT per acre, but these marshes were treated in total. The results obtained are given in Figure 1.

Results and Discussion. From the graph it can be seen that the marshes "banded" on July 19, 20 and 21, showed a slight decrease in population counts during the week following the spray application. This decrease, however, was only temporary and the emergence curve increased thereafter until a natural decline occurred during the week of August 12–18. No noticeable decline occurred in the trap counts taken in the marshes "banded" on July 22 and 23 and the emergence pattern continued to approximate that of the untreated marshes very closely.

The three marshes in which the total marsh area was treated with the lower dosage of DDT, showed a decided decline in trap counts made the week following spray application. A slight increase in trap counts in these marshes occurred during the week of August 12–18 with a normal decrease thereafter. A slight increase in adult emergence was apparent in both treated and untreated marshes during September 3–8.

Conclusions. The results of our tests show that during the summer of 1958 banding the upland margins of salt marsh with DDT-oil applied at the rate of 1.5 pounds of actual DDT per acre did not effectively reduce greenhead populations in the marsh areas treated. However, total spraying of marshes with DDT-oil applied at the rate of 0.6 pound of DDT per acre reduced the greenhead population approximately 95 percent the week following spray applications; but the slight increase in trap counts taken the second week following spray application, indicates that the effectiveness of the insecticide was limited to approximately one week.

Larval Sampling

Materials and Methods. Two methods of larval sampling (New Jersey larvicide square-yard samples and Berlese funnel square-foot samples) were successfully employed during the summers of 1954–1956 on Long Island by Wall and Jamnback (1957). Using these two methods, a total of 99 square-yard samples and 56 Berlese funnel samples were taken during the summer from salt marshes in the vicinity of Yarmouth Port, Dennis, and Eastham. Normally, a series of three square yards was treated at one time and at least one square foot sample was taken adjacent to the square yard plots.

Results and Discussion. The average number of *Tabanus* larvae emerging per square yard was 1.8 while the average collected from a Berlese funnel sample was 1.3. If it is assumed that all the *Tabanus* larvae present in a square foot of sod were collected, then, on a comparative basis, only about 15 percent of those present in a square yard of salt marsh came to the surface following application of the irritant. These results appear to be in general agreement with the results obtained on Long Island by Wall and Jamnback (1957) where a correlation figure of about 13 percent was obtained.

Samples were taken at random on the marshes and larvae were found to be fairly well distributed throughout the marsh areas. They were found close to the upland, a few feet from open water, and up to 300 yards out into the marsh from the upland.

From both methods of larval sampling mentioned above, the following species were collected and identified: *T. lineola, T. nigrovittatus, C. atlantica* and *C. fuliginosa.* A complete list of the identified species of adult and larval Tabanidae collected during our survey is given in the summary.

HELEIDAE

Jamnback *et al.* (1958) recorded three species of this family as being particularly abundant and annoying on Long Island. These species were: *Culicoides canithorax* Hoffman, *C. furens* (Poey) and *C. melleus* (Coq.). This last named species is an intertidal sand breeding form while the other two species apparently breed in salt marsh mud (Goulding *et al.* 1953, Bidlingmayer 1957, Jamnback and Wall 1958). Since the environments and biotic communities of Long Island and Cape Cod are very similar, we expected to find these same species prevalent on Cape Cod. All three species have previously been recorded from Cape Cod by Coher *et al.* (1955).

Adult Sampling

MATERIALS AND METHODS. Four light traps were set up in widely dispersed areas on Cape Cod and in each instance were adjacent to both salt marsh and intertidal sand. Two traps remained in the same locality throughout the summer (June 23–August 2); one was moved to a mosquito breeding site on July 27 and one became inoperative due to mechanical failure on this same date.

RESULTS AND DISCUSSION. A total of 4082 *C. melleus,* 518 *C. furens,* 32 *C. canithorax* and 2 *C. spp.* were collected from the light traps during the summer. The presence of large numbers of *C. melleus* was also noted by personal observations made throughout the summer. There appeared to be a definite lack of correlation between the large numbers of *C. furens* and small numbers of *C. canithorax* taken in the light traps, and our other findings in regard to these two species. For example, a total of 47 biting adult *Culicoides* collected in the salt marshes on various dates throughout the summer all proved to be *C. canithorax.* Our larval samples from salt marsh mud proved to contain a very high percentage of *C. canithorax* and a very low percentage of what we believe to be *C. furens* larvae; the exact reverse of our light trap counts. It is possible that *C. canithorax* is not particularly attracted to lights or this species may not be active during periods of dusk and darkness. These hypotheses are somewhat substantiated by the findings of Jamnback *et al.* (1958) on Long Island where one light trap yielded approximately 1500 dark winged *Culicoides* of which about 2 percent were *C. canithorax* and 98 percent *C. furens.* We feel, however, that we did not have a sufficient number of light traps operating throughout the Cape Cod area to obtain a true picture of adult *Culicoides* populations.

Larval Sampling

MATERIAL AND METHODS. Numerous areas of intertidal sand in the vicinity of Oyster Harbors, Cotuit and East Falmouth were sampled for *Culicoides* larvae using the method described by Jamback and Wall (1958). The method used to sample *Culicoides* larvae in marsh mud was modified slightly from that of Bidlingmayer (1957). Samples of marsh mud approximately equal to one-third pint were brought to the laboratory and each placed in a pint jar. Each mud sample was then covered with dry beach sand to a depth of about 1½ to 2 inches, flooded with tap water and allowed to stand overnight. During this time a high proportion of the larvae migrated into the sand. The next day the sand was removed from a sample and "washed" to remove the larvae as described by Jamnback and Wall (1958).

RESULTS AND DISCUSSION. Several hundred larvae were obtained from the intertidal sand samples and representative larvae were identified as *C. melleus.* The type of beach area in which the larvae were found varied from fine, clean sand to bands of stones and pebbles overlying sand and mud mixtures. Many were

found beneath stands of *Spartina alterniflora* growing in the intertidal sand. The location of the larvae between the high and low tide marks appeared to vary from locality to locality. In some instances, the larvae were found close to the low tide point, in others they were located midway between the high and low tide marks. The majority of the larvae were found in protected bays and inlets and were scarce or absent along areas exposed to heavy wave action. These findings are in general agreement with those of Jamnback and Wall (1958) on Long Island.

A total of 741 larvae were recovered from marsh mud samples and 388 specimens were identified. Of these, 97 percent were identified as *C. canithorax* and 3 percent tentatively identified as *C. furens*. Six larvae tentatively identified as *C. furens* were reared to adults and the identification in each case proved to be correct.

The majority of the larvae were found in the top inch of mud, but we have recovered them from samples taken to a depth of three inches in areas pocketed with fiddler crab holes. Although no attempt was made to locate them at greater depths, undoubtedly they will occur there since Bidlingmayer (1957) found *C. furens* larvae to a depth of 24 inches in Florida marshes.

We found the greatest numbers of larvae along the edges of bays and drainage ditches where long *Spartina alterniflora* is the predominant plant cover. However, the larvae were found widespread throughout all salt marshes sampled. They were recovered from moist or wet mud with *Spartina alterniflora, Spartina patens, Distichlis spicata* and *Salicornia* spp. as the dominant plant cover. None were recovered from soft, dry soil or from areas where the marsh surface was hard. These findings are in general agreement with those of Jamnback and Wall (1958) and Bidlingmayer (1957).

CULICIDAE

Our preliminary investigations of the mosquito problems on Cape Cod were largely confined to rearing and identifying the various species encountered in the field. A list of the identified species with locality data will be included in a later paper.

SUMMARY

Tanglefoot traps were used to sample adult Tabanidae in salt marshes on Cape Cod during the summer of 1958. *Tabanus lasiophthalmus* Macquart, *T. lineola* Fab., *T. nigrovittatus* Macquart, *Chrysops atlantica* Pech., *C. carbonaria* Walker, and *C. fuliginosa* Wied. were recorded on the traps. *T. nigrovittatus,* the greenhead fly, was the principal species found throughout the summer. The typical emergence peak of this species was two to three weeks later than normal in 1958.

A greenhead adult control program was carried out in the salt marshes during July and August. Results showed that banding the upland margins of marshes with DDT-oil spray applied at the rate of 1.5 pounds of actual DDT per acre did not effectively reduce greenhead populations. Total treating of the marshes with the same insecticide at the rate of 0.6 pound of actual DDT per acre reduced adult populations approximately 95 percent.

Marsh sod was sampled for tabanid larvae using the New Jersey larvicide square-yard method and Berlese funnel square-foot method. Small numbers of larvae were found distributed throughout the marsh and the following species determined: *T. lineola, T. nigrovittatus, C. atlantica* and *C. fuliginosa.*

The following adult Tabanidae were also collected at various localities on Cape Cod: *Chrysops aberrans* Philip, *C. carbonaria* Walker, *C. delicatula* Osten Sacken, *C. dimmocki* Hine, *C. frigida* Osten Sacken, *C. vittata* Wiedemann, *Tabanus atratus* Fabricius, *T. atratus nantuckensis* Hine, *T. cinctus* Fabricius, *T. nigripes* Wiedemann, *T. novae-scotiae* Macquart, *T. pumilus* Macquart, *T. trispilus* Wiedemann, and *T. typhus* Whitney.

Adult Heleidae were sampled throughout the summer using a limited number of light traps. The following nuisance species were recorded: *Culicoides cani-*

thorax Hoffman; *C. furens* (Poey); and *C. melleus* (Coq.). *C. melleus* was the most common species occurring throughout the summer. Larval samples were taken in the suspected habitats of these species. *C. melleus* was found in protected sections of intertidal sand and *C. furens* and *C. canithorax* in moist or wet marsh mud.

Numerous species of mosquitoes were reared and identified. A list of these species will be included in a later paper.

The authors wish to acknowledge the aid of the following persons: Dr. L. L. Pechuman, Lockport, New York for his identification of the adult *Chrysops* and *Tabanus;* and Dr. W. W. Wirth, United States Department of Agriculture for his identification of representative larvae and adult *Culicoides.*

References Cited

BIDLINGMAYER, W. L. 1957. Studies on *Culicoides furens* (Poey) at Vero Beach. Mosquito News 17(4):292–294.

COHER, E. I., WIRTH, W. W. and KNUTSON, H. 1955. *Culicoides* of New England (Diptera: Heleidae). Mosquito News 15(3):153–155.

GERRY, B. I. 1950a. Control of salt marsh tabanids by means of residual DDT-oil spray. Jour. Econ. Ent. 42(6):888–890.

———. 1950b. Salt marsh fly control as an adjunct to mosquito control in Massachusetts. Proc. 37th Ann. Meeting N. J. Mosq. Exterm. Assoc., pp. 189–193.

GOULDING, R. L., CURRAN, R. F. and LABRECQUE, G. C. 1953. Insecticides for control of sand flies in Florida. Jour. Econ. Ent. 46(1):37–43.

HANSENS, E. J. 1952. Some observations on the abundance of salt marsh greenheads. Proc. 39th Ann. Meeting N. J. Mosq. Exterm. Assoc., pp. 93–98.

JAMNBACK, H. and WALL, W. J. 1958. A sampling procedure for *Culicoides melleus* (Coq.) (Diptera: Heleidae) with the observations on the life histories of two coastal *Culicoides.* Mosquito News 18(2):85–88.

———. 1959. The common salt-marsh Tabanidae of Long Island, New York. N. Y. State Mus. Bull. 375:1–77.

JAMNBACK, H., WALL, W. J. and COLLINS, D. L. 1958. Control of *Culicoides melleus* (Coq.) (Diptera: Heleidae) in small plots with brief descriptions of the larvae and pupae of two coastal *Culicoides.* Mosquito News 18(2):64–70.

PECHUMAN, L. L. 1957. The Tabanidae of New York. Proc. Rochester Acad. Sci. 10(3): 1–182.

WALL, W. and JAMNBACK, H. 1957. Sampling methods used in estimating larval populations of salt marsh tabanids. Jour. Econ. Ent. 50(4): 389–391.

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TEXAS BLACKFLY RECORDS (DIPTERA: SIMULIIDAE)

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State Department of Health, Austin, Texas

A review of the literature reveals published records of nine species of blackflies from Texas localities. Eight are species of *Simulium* Latreille and the ninth referable to the genus *Cnephia* Enderlein. With one exception none of the published Texas records are of recent date and each was reported from only one or two localities. Our collecting efforts demonstrated an additional species. In a personal communication Dr. Alan Stone of the U. S. National Museum provided us with unpublished records of four additional species of *Simulium* together with many additional locality records for most of the previously reported species of Texas blackflies. We wish to express our sincere thanks to Dr. Stone for identifying blackfly material that we have collected, for graciously permitting us to include unpublished data supplied by him, and for suggestions incident to the preparation of this manuscript.

In the course of our continuing statewide vector surveillance program it has been possible for us to search for blackfly breeding in streams over a rather extensive area of Texas. Our collecting efforts, coupled with information furnished by Dr. Stone, indicate that blackflies are widespread and relatively abundant in Texas and, at least in the central and southern areas of the state, that breeding continues throughout the year. In recent years residents of Austin, Texas, have complained of being bitten by gnats while out of doors during the summer months. Investigation showed these bites to be caused by *S. mediovittatum* Knab. Here this species swarms about human beings, especially at their ankles, but is usually hesitant about attacking. Once they have begun to feed they are not easily alarmed and engorge rapidly. The bites are almost immediately painful and the sites swell into pronounced welts in a short time. This is usually accompanied by an intense irritation which persists for a day or longer. Several instances of systemic disturbance, possibly allergic in nature, have been called to our attention following *S. mediovittatum* bites. An extensive search was made in the Austin area and but a single breeding site for this species discovered—in the Colorado River adjacent to the City Power Plant. Here water cascades over a streamwide, man-made chain of rocks and large fragments of concrete, erected to impound water for municipal uses. Human annoyances by *S. mediovittatum* occurred up to eight miles distant from this breeding area. It is quite possible that similar situations occur in other Texas cities but reports of such occurrences have not come to our attention. We have received no complaints of annoyance by biting gnats from hunters and fishermen.

Utilizing large, home aquaria, well aerated with a device attached to a compressed air supply, we have had no difficulty rearing adult blackflies from larvae or pupae in our insectary. We observed many pupal cases to contain one to several water mites (Hydracnellidae). Very frequently we found one or more of these mites attached to emerged adult blackflies and we regard this phenomenon as an example of phoresy.

There is a general tendency amongst entomologists to consider the Simuliidae of the United States to be represented by five genera, viz., *Prosimulium* Roubaud 1906, *Parasimulium* Malloch 1914, *Eusimulium* Roubaud 1906, *Simulium* Latreille 1802, and *Cnephia* Enderlein 1921.

In the following tabulation of blackfly records, those marked with an asterisk (*) represent data furnished by Dr. Stone and all collections dated April 1941 were made by him. The stage or stages reported are indicated in the following manner: A—adult; P—pupa; L—larva.

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Simulium argus WILLISTON 1893

Not previously reported from Texas. This species, considered identical with *vittatum* by Malloch (1914), is regarded as a valid species by Dr. Stone. Texas records are as follows:

Medina County
Hondo River, Oct. 16, 1957, P
*Hondo Creek, Apr. 20, 1941, P
Burnet County
Unnamed stream, Feb. 2, 1958, L
Uvalde County
*Sabinal, Mar. 22, 1911, A
*Sabinal River, Apr. 20, 1941, P
*Uvalde, Dec. 28, 1923, P
Travis County
*Small stream south of Austin, Apr. 19, 1941, P
*Slaughter Creek, Apr. 19, 1941, P
Menard County
*Los Morros Creek, Apr. 23, 1941, P
*San Saba River, Apr. 23, 1941, P
Kerr County
*Kerrville, Mar. 1955, L, P
Val Verde County
*Devil's River, Juno, June 13, 1953, L, P

Simulium bivittatum MALLOCH 1914

Not previously recorded from Texas. Texas records are as follows:

Menard County
*Los Morros Creek, May 22, 1939, A
Collin County
*McKinney, Mar. 28, 1913, A

Simulium jenningsi MALLOCH 1914

Not previously recorded from Texas. Texas records are as follows:

Kerr County
*Kerrville, June 1, 1953, A
Cherokee County
*Unnamed stream west of Jacksonville, Apr. 17, 1941, P

Simulium mediovittatum KNAB 1915

Type locality Arlington, Tarrant County, Texas, Oct. 28, 1914. Dyar and Shannon (1927) list this species from Bay City, Matagorda County, Texas, Jan. 26, 1911. Additional Texas records are as follows:

Travis County
Austin, July 8, 1955, A
Sandy Creek, July 5, 1957, P
Barton Creek, July 29, 1957, L, P
Onion Creek, July 13, 1957, L, P
Colorado River, Aug. 18, 1957, L, P
Colorado River, Jan. 22, 1958, L, P
*Austin, Aug. 26, 1955, A
Medina County
Hondo River, Oct. 16, 1957, L, P
Kinney County
Pinto Creek, Oct. 15, 1957, L, P
Hamilton County
Partridge Creek, Nov. 13, 1957, L, P
Cowhouse Creek, Nov. 13, 1957, L
Lampasas County
Lampasas River, Nov. 13, 1957, L
Burnet County
Lampasas River, Nov. 13, 1957, L
Nueces County
Nueces County, Dec. 10, 1958, L, P
Zavala County
*Crystal City, June 21, 1935, A
Uvalde County
*Leona River, Apr. 21, 1941, P
Menard County
*San Saba River, Apr. 23, 1941, P
*Los Morros Creek, Oct. 1, 2, 9, 1942, A, P
*Los Morros Creek, July 3, 1940, A
*Los Morros Creek, May 22, 1939, A
Dimmit County
*Winter Haven, June 21, 1935, A

Simulium meridionale RILEY 1886

Recorded, as *S. occidentale* Townsend 1891, by Dyar and Shannon (1927) from Liberty, Liberty County, Texas, Mar. 19, 1908, and Dallas, Tarrant County, Texas, June 2, 1922. Additional Texas records are as follows:

Cameron County
*Brownsville, June 2, 1904, A
Tom Green County
*Christoval, Sept. 5, 1941, L, P
Brazos County
*College Station, 1945, A

Nueces County
*Corpus Christi State Park, Oct. 6, 1951, A

Simulium notatum Adams 1904

Recorded by Dyar and Shannon (1927) from Devil's River, Texas, May 6, 1907. In a personal communication Dr. Stone states that he believes Dyar and Shannon misidentified this species and that it does not occur in Texas.

Simulium slossonae Dyar and Shannon 1927

Not previously reported from Texas. Texas records are as follows:

Leon County
*Buffalo Creek, Apr. 18, 1941, L, P

Simulium solarii Stone 1948

Type locality San Saba River, Menard County, Texas, Apr. 23, 1941. In his description of this species Stone (1948) designated as paratypes specimens collected in Menard, Travis, Uvalde, Val Verde, Kerr, and Burnet counties. Additional Texas records are as follows:

Travis County
Barton Creek, July 29, 1957, L
Onion Creek, July 13, 1957, L, P
Hays County
Hamilton County, July 13, 1957, L, P
Kerr County
Guadalupe River, Sept. 21, 1957, L, P
Guadalupe River, Sept. 21, 1957, L, P
Burnet County
Unnamed stream, Feb. 2, 1958, L, P

Simulium trivittatum Malloch 1914

Recorded by Malloch (1914) as *S. distinctum* new species from Devil's River, Texas, no date, and by Dyar and Shannon (1927) from Devil's River, Texas, May 5, 1907, and from Victoria, Victoria County, Texas, Dec. 13, year not given. Additional Texas records are as follows:

Val Verde County
Creek in Del Rio, Texas, Oct. 18, 1957, L, P
Lampasas County
Lampasas River, Nov. 13, 1957, P
Burnet County
Lampasas River, Nov. 13, 1957, P
Unnamed stream, Jan. 22, 1958, P
Unnamed stream, Jan. 22, 1958, P
Unnamed stream, Jan. 22, 1958, P
Unnamed stream, Jan. 22, 1958, L, P
Travis County
Bull Creek, Dec. 15, 1957, P
Bull Creek, Dec. 15, 1957, L
Unnamed stream, Dec. 15, 1957, L
Williamson County
S. San Gabriel River, Dec. 16, 1957, L, P
S. San Gabriel River, May 20, 1958, P
*Large stream southwest of Hutto, Apr. 18, 1941, P
Tom Green County
Concho River at Christoval, Apr. 20, 1959, L, P
Uvalde County
*Sabinal River, Apr. 20, 1941, P
*Leona River, Apr. 21, 1941, P
*Nueces River, Apr. 21, 1941, P
*Nueces River, Sept. 7, 1941, P
Edwards County
*Pulliam Creek, Apr. 22, 1941, P
Kimble County
*S. Llano River, Apr. 22, 1941, P
Menard County
*Los Morros Creek, Apr. 23, 1941, P
*San Saba River, Apr. 23, 1941, P
*Clear Creek, Apr. 23, 1941, P

Simulium venustum Say 1829

Recorded by Dyar and Shannon (1927) from 'Texas.' An additional Texas record is as follows:

Cherokee County
*Two streams near Jacksonville, Apr. 17, 1941, P

Simulium tuberosum (Lundstroem) 1911

Not previously reported from Texas.

Rusk County
*Sampson Creek, Apr. 17, 1941, P

Simulium virgatum Coquillet 1903

Recorded by Dyar and Shannon (1927) from Devil's River, Texas, May 5, 1907,

and by Stains and Knowlton (1936) from 'Texas.' Additional Texas records are as follows:

Hays County
Bear Creek, July 8, 1957, A, L, P
Travis County
Bull Creek, Dec. 15, 1957, L
Bull Creek, Dec. 15, 1957, P
Unnamed stream, Dec. 15, 1957, L
*Small stream south of Austin, June 19, 1941, L, P
Nueces County
Nueces River, Dec. 10, 1957, L
Burnet County
Unnamed stream, Feb. 2, 1958, P
Unnamed stream, Feb. 2, 1958, P
Bexar County
Helotes Creek, Apr. 5, 1958, L, P
Bell County
San Gabriel River, May 20, 1958, L
Williamson County
San Gabriel River, May 20, 1958, P
*Large stream southwest of Hutto, Apr. 18, 1941, P
Menard County
*Los Morros Creek, May 22, 1939, A
Los Morros Creek, Apr. 12, 1943, A
*San Saba River, Apr. 23, 1941, P
Edwards County
*Spring near Llano River, Apr. 22, 1941, P
Medina County
*Hondo Creek, Apr. 20, 1941, P
Uvalde County
*Sabinal River, Apr. 20, 1941, P
*Frio River, Apr. 21, 1941, P
Zavala County
*Nueces River, Apr. 20, 1941, P

Simulium vittatum ZETTERSTEDT 1835

Recorded by Dyar and Shannon (1927) from Sabinal, Uvalde County, Texas, Mar. 22, 1911, and by Vargas (1945) from Los Morros Creek, Menard, Menard County, Texas, July 3, 1940. Additional Texas records are as follows:

Tom Green County
Concho River at Christoval, Apr. 20, 1959, L, P
Concho River at San Angelo, Apr. 21, 1959, L, P
McCulloch County
San Saba River southeast of Brady, Apr. 22, 1959, L, P, A
Travis County
Colorado River at Austin, 1959, L, P
Rusk County
*Outflow from Henderson water supply, Apr. 17, 1941, L, P
Cherokee County
*Sampson Creek, Apr. 17, 1941, P
*Stream east of Jacksonville, Apr. 17, 1941, L, P
*Stream west of Jacksonville, Apr. 17, 1941, L, P
*Spillway from culvert east of Nueces River, Apr. 17, 1941, P
Anderson County
*Stream north of Palestine, Apr. 18, 1941, L, P
Leon County
*Buffalo Creek, Apr. 18, 1941, L, P
Robertson County
*Stream west of Ridge, Apr. 18, 1941, L, P
Medina County
*Hondo Creek, Apr. 20, 1941, P
Uvalde County
*Leona River, Apr. 21, 1941, P
*Nueces River, Apr. 21, 1941, P
Menard County
*Los Morros Creek, Apr. 23, 1941, P
*San Saba River, Apr. 23, 1941, P
*Clear Creek, Apr. 23, 1941, P
Taylor County
*Small stream north of Abilene, Apr. 24, 1941, L, P
LaSalle County
*Nueces River at Cotulla, Apr. 4, 1941, A

Cnephia pecuaria (RILEY) 1886

Previously recorded, as *Eusimulium pecuarum* (Riley) by Dyar and Shannon (1927) from College Station, Brazos County, Texas, no date, and by Stains and Knowlton (1943) from Lufkin, Angelina County, Texas, Jan. 17, 1941. Additional Texas records are as follows:

Burnet County
Unnamed stream, Feb. 2, 1958, P

Grimes County
*Navasota, Mar. 11, 1946, A
Jasper County
*Kirbyville, Mar. 25, 1908, A

Summary

Nine species of blackflies have been previously reported from Texas, the identity of one of which (*S. notatum*) is questionable. In this paper, additional locality records are given for seven of these species. Texas locality records for five previously unrecorded species of *Simulium* are included bringing the total number of species definitely known to occur in the state to thirteen.

Literature Cited

Dyar, H. G. and Shannon, R. C. 1927. The North American two-winged flies of the family Simuliidae. Proc. U. S. Nat. Mus. 69(2636):1–54.

Malloch, J. R. 1914. American black flies or buffalo gnats. U. S. Dept. Agr. Bur. Ent. Tech. Ser. 26:1–72.

Stains, G. S. and Knowlton, G. F. 1943. A taxonomic and distributional study of Simuliidae of western United States. Ann. Ent. Soc. Amer. 36:259–280.

Stone, A. 1948. *Simulium virgatum* Coquillet and a new related species (Diptera: Simuliidae). J. Wash. Acad. Sci. 38:399–404.

———. 1959. Personal communication.

Vargas, L. 1945. Simulidos del neuvo mundo. Monografía Num. 1 del Inst. Sal. y Enf. Trop., Mexico, D. F., pp. 1–241.

MOSQUITO DENSITIES IN ORANGE COUNTY, TEXAS

R. B. Eads,[1] J. G. Foyle,[2] and R. E. Peel [1]

The flat coastal plains of Texas, with annual rainfall in excess of 50 inches and a moderate climate, are well-known to offer optimum conditions for the production of large mosquito populations. Orange County has a full complement of all of the drainage problems which are typical of the area. The county is shaped somewhat like a broad horseshoe with the higher land in the center and along the top or open end of the shoe. The still higher land areas of Newton and Jasper Counties adjoin Orange County on the north, and the uncontrolled surface water runoff from 104,000 acres of these higher lands is discharged into Cow Bayou, Adams Bayou and other Orange County streams.

The county boundaries to the east, the south and the west are two major rivers, the Sabine and the Neches. Both become tidal estuaries a few miles below the north boundary of the county, and the tidal marshes along the lower reaches of these rivers, particularly on the Neches, attain maximum widths of up to 4 miles between the river channel and the 5-foot contour. These rivers join at Lake Sabine, a salt water arm of the Gulf of Mexico which covers nearly 100 square miles. A 15-square-mile wedge of the lake is included in Orange County.

The area of Orange County is usually listed at 356 square miles or 227,840 acres. Recent computations by one of the authors (JGF) indicate a total area of 367 square miles to be included between the western bank of the Sabine River, the eastern bank of the Neches River and the Newton-Jasper County line. Approximately 84 square miles, or 53,760 acres, are either submerged or in tidal and river marshes, below the 5-foot contour, and cannot be drained by gravity. The land area above the 5-foot contour is approximately 283 square miles, or 181,120 acres. There are in Orange County some 32,256 acres of marshland below 3 feet in elevation; of this

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[2] County Engineer, Orange, Texas.

some 23,844 acres are below 2 feet in elevation. The area of marshland below 2 feet in elevation is continuously submerged or is subjected to continuous intermittent flooding because of the daily tidal fluctuation. During spring tides, the area of marshland above 2 feet in elevation, and below 3 feet in elevation comprising some 8,412 acres is also flooded.

A few small, flat knolls in the extreme northern part of the county reach an elevation of 30 feet above sea level, sloping down to the normal high tide level of the river marshes, which is about 3 feet above sea level, with natural gradients of 1 or 2 feet per mile. As a result, most of the natural streams and watercourses are very slow moving, and therefore very crooked.

The areas of residential development and the county's population are largely located on sites of 6 to 18 feet in elevation. The lands above 20 feet in elevation are chiefly in timber, pasture, and rice fields, with a good deal of wet prairie and some sawgrass marshes.

During the summer of 1958, New Jersey light traps were operated in all urban areas within Orange County to determine mosquito population densities and relative species abundance (Figure 1). This information was needed in order that the limited funds available for mosquito control might be most intelligently expended. The specimens were submitted to the Entomology Section, Texas State Department of Health, for identification.

The traps were operated in 30 locations for 148 trap nights from May 1 to September 10, 1958, in Orange (population 32,000), West Orange (population 2,539), Bridge City (population 5,500), Vidor (population 7,800), Mauriceville (population 700) and Orangefield (population 1,000). Meteorological data taken during this period are given in Table 2.

As shown in Table 1, a total of 18,076 mosquitoes of 24 species were taken. An average of 122.14 per trap night was obtained. Of particular interest was the fact that only 4.4 percent were *Aedes sollicitans* and a negligible number *A. taeniorhynchus*. Excluding the *Uranotaenia* which are not believed to bite human beings, 5.8 percent of the mosquitoes were *sollicitans*.

These results were somewhat surprising; even though light traps do not directly reflect the number of *sollicitans* flying and biting during daylight hours, the species is generally regarded as being sufficiently attracted to light during nocturnal operational periods to make light traps useful in measuring population densities.

It is not our intention to minimize the salt-marsh mosquito problem in the Gulf Coast area. However, many of the salt

TABLE 1.—Relative abundance of mosquitoes collected in light traps at Orange, Texas, May 1–September 10, 1958

Uranotaenia lowii	4,250
Psorophora confinnis	4,100
Anopheles crucians	3,900
Culex quinquefasciatus	2,444
Aedes sollicitans	798
Anopheles quadrimaculatus	631
Mansonia perturbans	510
Culex salinarius	385
Aedes vexans	354
Aedes mitchellae	347
Aedes taeniorhynchus	81
Culex erraticus	81
Uranotaenia sapphirina	61
Psorophora discolor	32
Psorophora ferox	30
Anopheles atropos	27
Anopheles walkeri	16
Psorophora signipennis	10
Aedes thelcter	5
Aedes trivittatus	4
Aedes atlanticus	4
Culiseta melanura	4
Orthopodomyia signifera	1
Psorophora ciliata	1
Total	18,076

TABLE 2.—Meterological data from U. S. Weather Bureau, Port Arthur, Texas

Month	Precipitation	Average daily maximum and minimum temperatures
May	2.69	76.2
June	1.93	82.8
July	5.65	84.0
August	2.59	82.8
September	14.59	79.2

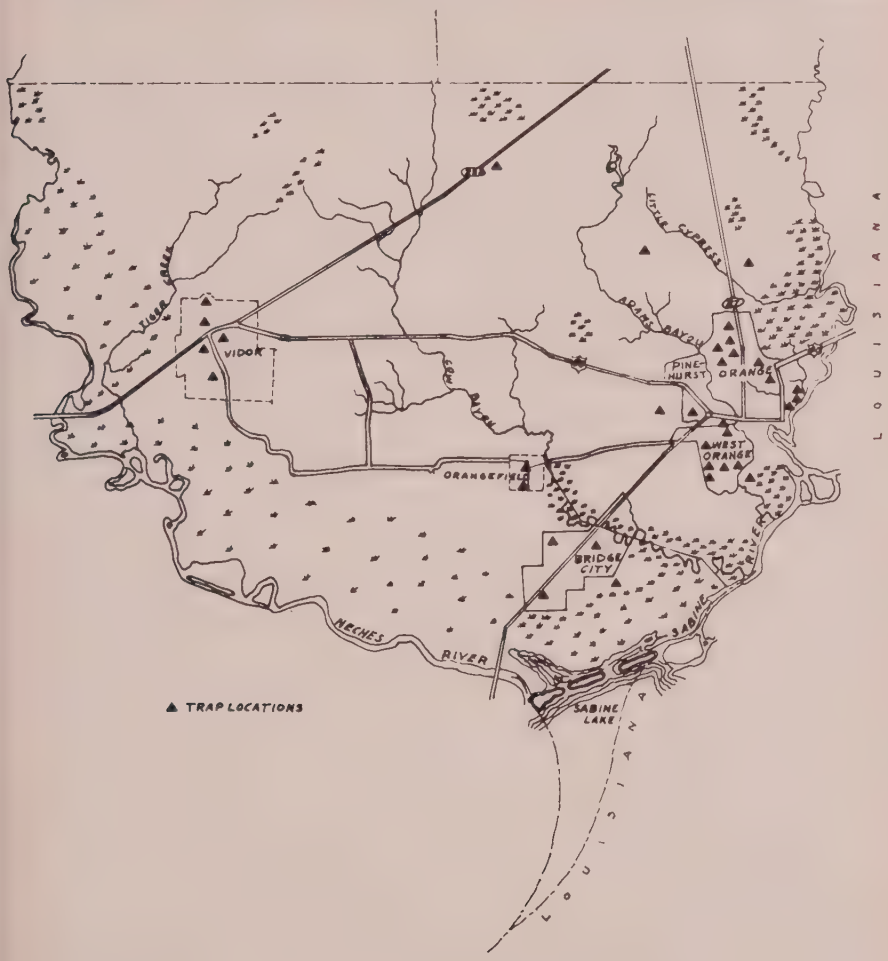

FIG. 1.—Map of Orange County, Texas, showing location of light traps.

marshes in which *sollicitans* menace sportsmen and domestic animals are well removed from populated areas. Dispersal by flights or as a result of high winds to urban areas may necessitate the use of adulticides against them. Promotion of mosquito abatement along the Texas Gulf Coast is sometimes adversely affected by the feeling that the problem presented by *sollicitans* breeding in salt marshes well removed from inhabited areas or even in other counties is of such a magnitude as to render localized control in and around municipalities of little value. However, the Orange County light trap catches indicate that this is not necessarily the case and that control personnel should not become so involved with salt-marsh mosquitoes that basic source reduction within or adjacent to urban areas is neglected.

The most abundant pest species as indicated by light traps was *Psorophora con-*

finnis. This flood-water mosquito is difficult to control in the larval stage, since only 4 or 5 days may be required for larval development during the summer months; thus, a limited amount of time is available for larviciding from inundation of the eggs to adult emergence.

The permanent-water-breeding *Anopheles, Culex* and *Mansonia* constituted over 60 percent of the mosquitoes taken, exclusive of the *Uranotaenia,* indicating the need for permanent control measures such as drainage and aquatic vegetation suppression.

The appreciable number of *Culex quinquefasciatus* taken was indicative of large populations of this mosquito, since the light trap has generally been found to be comparatively ineffective in attracting this species. In addition to being extremely pestiferous, *C. quinquefasciatus* is believed to be the principal vector of St. Louis encephalitis in the southern portion of the state. Larval development is heaviest in waters with high organic content, frequently produced in connection with municipal or individual disposal of sewage or other wastes. Breeding is usually concentrated and the larvae vulnerable to relatively simple and inexpensive control procedures. This common house mosquito should receive primary consideration in formulating and applying control measures. In areas of St. Louis endemicity, it is advisable that cities or counties with inadequate budgets institute species control measures against *C. quinquefasciatus.* Since it invades dwellings and attacks man freely, it is a major pest species, as well as a disease vector.

SUMMARY. Three light traps were operated in the County of Orange, Texas, from May 1 to September 10, 1958. A total of 18,076 mosquitoes were taken in 148 trap nights. Less than 10 percent of the mammal-biting species were *Aedes sollicitans* and *A. taeniorhynchus.*

DDT-RESISTANT ADULTS OF *ANOPHELES SUBPICTUS* IN THE LAHORE DISTRICT OF WEST PAKISTAN

J. MALDONADO-CAPRILES [1] AND A. S. NASIR [2]

Susceptibility tests were performed by the authors with wild caught adults of *Anopheles subpictus* Grassi in two DDT-sprayed villages near Lahore, West Pakistan. The data collected, although somewhat meager, show a definite resistance to DDT by this species in this locality. Pronounced DDT-resistance in this species was found in 1956 at Jawalaheri and Nanglischidar, Uttar Pradesh, India, by Sharma and Krishnamurthy (1, 5) and recently by Pant (2) in Nepal. The species, as detailed below, has been reported to be relatively susceptible in Java by various authors (3).

Anopheles subpictus, for reasons still unknown, is not a vector of malaria in West Pakistan. However, it is a vector in some areas of Indonesia. In West Pakistan this species is extremely abundant after the monsoon rains, i. e., usually during the months of July and August. Larvae are found in great numbers in temporary and permanent pools. The adults freely enter buildings and are collected with great ease at any time during the day.

The susceptibility tests discussed herein were performed with the kit once provided

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by the International Cooperation Administration (4). The DDT-saturated papers used were those provided and obtainable from WHO-Geneva. An interesting fact is that the DDT-papers were 17 months old at the time of the tests. The papers were impregnated on 22–29 March 1957 and the tests performed in August 1958. Test performed by the Communicable Disease Center's Technical Development Laboratories at Savannah, Georgia, USA, showed that the DDT-papers were fully potent at the time of usage. Using *Anopheles quadrimaculatus* Say as the test insect, at an exposure of one hour the average mortality from three replicates with 1, 2, and 4 percent DDT-papers were 3 and 5 percent, 64 and 64 percent, and 96 and 99 percent. The first figure of these percentages refer to the papers used in Pakistan and the second to papers impregnated in January 1958.

The tests performed in West Pakistan were made with DDT concentrations of 0.25, 0.5, 1.0, 2.0, and 4.0 percent. The exposure times used were 1, 2, and 4 hours. At one hour exposure the highest kill with 4 percent papers was 20.0 percent. For comparison it can be mentioned that in tests performed in Java with the same species and with specimens from four localities, with 4 percent papers and one hour exposure, mortalities of 95, 82, 89, and 100 percent were obtained (2). At two hours exposure the highest kill with 4 percent papers was 56.2 percent. At 4 hours exposure (in a second village) the highest kill was 70.0 percent. A summary of the results is tabulated below.

Summary. 1. Preliminary tests done

TABLE 1.—DDT-resistance studies with adults of *Anopheles subpictus* in West Pakistan, August 1958

Summary of Results

A. Village Chung, 14 miles west from Lahore, on the Montgomery road; village sprayed twice, last in 1956.

Tests 1, 2, 3; August 7 and 8, 1958. One hour exposure.

Concentration of DDT	No. of replicates	Total No. of adults	Total No. dead at 24 hrs.	Percent dead	Temperatures*
Control	6	139	0	0.0	
0.25	6	157	1	0.6	92 Max.
0.50	6	150	0	0.0	84 Min.
1.0	6	154	2	1.3	83 Wet
2.0	3	71	3	4.2	87 Dry
4.0	3	73	8	10.9	

Tests 4, 5; August 9, 1958. Two hours exposure.

Control	2	49	0	0.0	
0.25	2	42	0	0.0	89 Max.
0.50	4	57	2	3.5	81 Min.
1.0	4	87	5	5.7	82 Wet
2.0	4	92	15	16.3	91 Dry
4.0	4	81	40	49.3	

B. Cattle-shed on eastern end of military cantonment, east from Lahore; area sprayed an unknown number of times.

Test 6; August 26, 1958. Four hours exposure.

Control	1	21	1	4.7	94 Max.
0.5	3	65	7	10.7	80 Min.
1.0	3	65	16	24.6	79 Wet
4.0	3	52	28	53.8	83 Dry

* Highest and lowest of 3 and 2 sets of readings for 1- and 2-hour exposure tests respectively.

with a standard susceptibility kit showed that *Anopheles subpictus* Grassi exhibits a definite resistance to DDT in the Lahore District of West Pakistan.

2. The DDT-impregnated papers used in these tests although 17 months old were found to be fully potent.

References

1. SHARMA, M. I. D. and KRISHNAMURTHY, B. S. Bull. Nat. soc. India Malar. 5:78. 1957 (In: The insecticide resistance problem. A review of developments in 1956–57. A. W. A. Brown, Bull. W.H.O. 18(3):p. 312. 1958.)

2. ANONYMOUS. Summary of occurrences of insecticide resistance in anopheline mosquitoes (all regions) and of results of susceptibility tests by the WHO method in the Americas. WHO/Mal/224, WHO/Insec/95. 1 May 1959.

3. ANONYMOUS. Second assessment of susceptibility to insecticides in anopheline mosquitoes. WHO/Mal/203, WHO/Insec/77. 23 April 1958.

4. MATHIS, W., SCHOOF, H. F., and FAY, R. W. Method of field determination of susceptibility levels of adult mosquitoes. Mosquito News. In press.

5. SHARMA, M. I. D. and KRISHNAMURTHY, B. S. Development of resistance to DDT in *A. subpictus* Grassi, 1899, in a Delhi State village. Bull. Natl. soc. India for Malaria and other Mosquito-Borne Dis. 5(1):78–81. 1957.

MANAGER WANTED

Well-equipped metropolitan mosquito control district is interested in obtaining applications from qualified candidates for the position of manager.

Applicants should have broad experience and/or training in the planning and conducting of mosquito or other insect control programs.

Attractive salary and other benefits. Apply to

James N. Lesparre, President

South Cook County Mosquito Abatement District

P. O. Box 30 Harvey, Illinois

OPERATIONAL AND SCIENTIFIC NOTES

A Simple Method for Determining Airplane Swath Pattern.—Since 1946 the Kern Mosquito Abatement District has been one of the pioneers in the use of aircraft for mosquito larval control in California (Geib 1946). During the early years only the most meager information was available for aircraft use in this specific type of operation, so pioneering was a matter of necessity rather than choice. In 1947, Magy, Dahl, et al., in cooperation with the Kern District, completed tests to determine swath width, mass medium droplet diameter, foliage penetration, etc. These tests were completed utilizing magnesium oxide coated microscope slides, which they floated on wooden blocks during the aircraft spraying. While results by this method of approach revealed the great over-all value of aircraft use for mosquito control in a variety of situations, it involved many man-hours' labor both in the field and laboratory before results could be fully ascertained.

This past season, the District had occasion to determine and compare the swath width of two different types of aircraft, and it was imperative that the work be completed in as short a period as possible, because of the limited availability of the planes. The time and man power involved in the use of magnesium coated slides was out of the question at that particular period, so an abbreviated method had to be decided upon. The simple technique finally employed worked so well, that we felt the information should be passed on to others who may have occasion to make a similar evaluation.

The District had on hand a supply of fluorescine dye, surplus navy sea-marker, part of which had been used in tagging adult *Aedes nigromaculis* while checking their flight in 1955. In a hasty check in the laboratory the sea-marker showed up very well on white butcher paper in a 10 percent water solution. Without further evaluation, the swath comparison check was set up for the next morning, utilizing the dye as a marker and butcher paper as the paper indicator.

The dye was pre-mixed in 5-gallon containers before pumping into the spray tank of the aircraft, as sea-marker goes into solution very slowly at this dilution. Meanwhile, the butcher paper was unrolled to a 100-foot length across the airstrip and weighted down on the edges with small piles of sand every ten feet or so, depending on the velocity of the prevailing breeze.

After the pilot made a flight across the paper spraying at the rate of one gallon per acre, an observation of swath width and pattern was recorded immediately. The center position of the flying aircraft was marked on the paper so that any type of correction that might be necessary on the boom could be immediately pin-pointed by viewing the paper. After observation, the paper was cut off at both ends beyond the swath pattern to lessen the bulk. The paper was then rolled together from both ends and marked, while another was unrolled for the next run. By this method the swath pattern of the two airplanes making three replicate runs at three different elevations for a total of 18 runs was completed in less than two hours. Work was begun in the early morning when wind velocity was at a minimum. Some difficulty was experienced with the paper by occasional gusts; however, the flying aircraft did not disturb the paper even at an altitude of only 10 feet.

Since the time these runs were made, several pilots as well as other interested persons have unrolled the sheets to prove one point or another. An issue becomes very clear and leaves little room for argument when the entire 70 to 80 foot width is laid before them for observation and study.

References Cited

Geib, Arthur F. 1946. Dr. Morris Mosquito Abatement District Airplane Work. Proceedings and papers of the Fifteenth Annual Conference of the California Mosquito Control Association, 125–128.

Magy, Harvey I, Dahl, Arve H., Geib, A. F. and Kirkwood, Seth. DDT larvicides dispersed by spray and thermal aerosol planes for the control of *Aedes dorsalis* (Meigen) and *Aedes nigromaculis* (Ludlow). Mosquito News, 1949, Vol. 9, No. 4:153–161.

—A. F. Geib, Mgr., and L. W. Isaak, Entomologist, Kern Mosquito Abatement District, Bakersfield, Calif.

The Ability of the Top Minnow, *Gambusia affinis* (Baird & Girard) to Reproduce and Overwinter in an Outdoor Pond at Winnipeg, Manitoba, Canada.—Only one record was found of the top minnow, *Gambusia affinis,* being introduced into Canada for mosquito control (Mail 1954). The minnows were released in 1924 at Banff, Alberta into warm springs, and observations made in 1953 showed that they were still present. This was the farthest north that top minnows had been successfully established. There are no records of *G. affinis* being established in a climate as severe as that which prevails in Manitoba. The normal mean temperatures during the coldest winter months of December, January and February are 6.6°, —2.1° and 2.1° F., respectively. Temperatures as low as —35° F. are not uncommon. The normal means for the warmest summer months of June, July and August are 61.9°, 67.1° and 64.4° F., respectively.

Because of the many reports of successful introductions of top minnows into some of the more northern states of the U. S. A., it was thought that these fish might be able to survive the cold winters of Manitoba. In September 1957, the late Mr. E. J. Stansfield, field manager of the

Greater Winnipeg Mosquito Abatement District arranged to have approximately 150 top minnows shipped to Winnipeg from the Desplaines Valley Mosquito Abatement District in Chicago where they are used extensively for mosquito control. Trials were conducted at the Department of Entomology, University of Manitoba to test their cold hardiness and reproductive potential under natural conditions in this area.

In May 1958, fifty top minnows were released into a pond (about 40′ x 80′ x 6′ deep) near the University of Manitoba. Within a month after their release a rapid increase in population was noted. Reproduction continued throughout the summer and by September there were an estimated 3,000 minnows in the pond. K. G. George of Harvard University states (in litt.) that there is no previous record of *G. affinis* reproducing in outdoor ponds in regions where average summer temperatures are as low as those in Winnipeg. A fairly heavy growth of water plants and an ample food supply in the form of small aquatic organisms made this pond an ideal breeding site for the fish.

In October 1958, about 1,000 top minnows were removed from the pond by use of a seine net and transferred to the laboratory. An estimated 2,000 minnows were left in the pond to test their ability to overwinter in this climate. Observations made during the seining operations showed that top minnows of all sizes were present, and that many of the females were fully distended with young. The fact that the females were entering the winter in this condition raised some doubt as to whether they could survive.

A survey of the pond made in late May 1959, after the ice had melted, showed that a good population of *G. affinis* had survived the winter and had begun to reproduce.

Gambusia affinis has for many years been an important tool in mosquito control programs in the U. S. A. If further overwintering trials definitely prove that top minnows can successfully overwinter in Manitoba, they would be very useful in mosquito control in permanent waters here. Indications are that the northern limit of their usefulness will be extended considerably in the near future.

Literature Cited

MAIL, G. A. 1954. Mosquito fish *Gambusia affinis* (Baird and Girard) in Alberta. Mosq. News 14:2, pp. 282–283.

—David L. Smith, Assistant, Provincial Entomologist, Extension Service, Manitoba Department of Agriculture and Conservation, Winnipeg, Manitoba. This work was done while the author was employed as a research assistant in the Department of Entomology, University of Manitoba, Winnipeg, Manitoba.

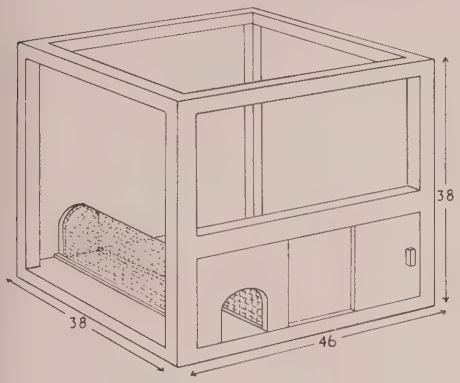
A CAGE SUITABLE FOR HOLDING AND FEEDING BLOOD-SUCKING MOSQUITOES.—In order to ensure oviposition in laboratory colonies of certain mosquitoes it is essential for the females to have regular blood meals. Blood-feeding may be carried out either by offering a living animal or by using preserved blood. Details of some of the numerous methods by which these two operations may be performed are given by Peterson (1955) and Trembley (1955). The present note deals with the design of a cage unit suitable for holding mosquitoes and for feeding them on a living animal.

When a small mammal is used for feeding mosquitoes, it is generally immobilised by a restraining device such as a rack and placed inside the mosquito cage. However, this method is attended by several disadvantages: feeding may occur on the delicate tissues of eyes or nostrils with consequent irritation and possibly inflammation, while the operation of inserting and removing the animal is invariably accompanied by some escape of mosquitoes into the breeding room. A recent modification of the Casanges-type animal holder by Jones and Scheltema (1956) minimises these disadvantages though it is still necessary to insert and remove the caged animal and construction of the all-metal holder is not simple.

An alternative to the above method is to hold the animal external to the mosquito cage. In this case it is common practice to anaesthetise the animal with nembutal (Leeson, 1952, communication in Trembley, 1955) place it on top of the cage and allow the mosquitoes to feed through the intervening net or wire mesh. Although such a method is intrinsically simple, it has the disadvantage of requiring time and labour for the various operations (weighing, injecting, cleaning, recording, etc.) which are involved.

Modifications of this second method, involving an externally-held but unanaesthetised animal—generally a mammal or bird—are also used, particularly when the mosquitoes are confined to a small container which can be fixed on, or applied to, some part of the host animal. Such methods are seldom employed when the mosquitoes are confined to a large cage, though Nieschulz (1930) devised one technique by which an unanaesthetised guinea pig could be held and restrained on the top of a large mosquito cage. The cage described below belongs to the same category as the latter since the guinea pig is confined to a compartment separated from that containing the mosquitoes by a wire screen, and it is through the latter that feeding occurs. Among the advantages which it offers are the following: feeding does not occur on eyes or nostrils; no narcotisation is necessary; no escape of mosquitoes can occur; introduction and removal of the animal and also cleaning of the apparatus, is extremely simple and rapid.

The general construction of the cage is shown in Fig. 1. The dimensions can be altered to suit individual requirements; those given in the figures are intended to serve merely as a guide. Basically the device consists of a cubical wood cage with half glass front, nylon net sides and top, and a wire mesh tunnel (15 holes per inch) running from front to back and fixed to the floor of the



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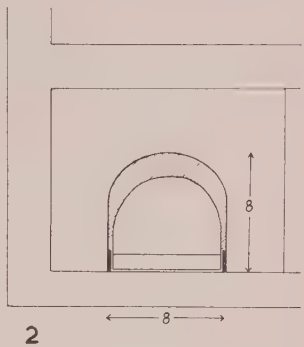

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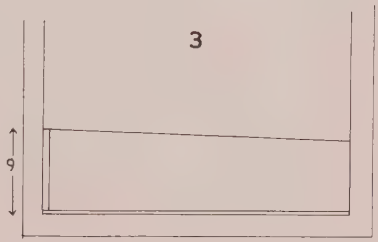

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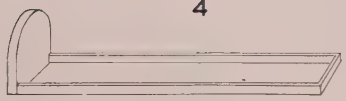

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Figs. 1–4.—Mosquito holding and feeding cage. 1. General view of cage. 2. Aperture to wire mesh tunnel with tray *in situ*. 3. Wood tray with vertical stop at rear end. 4. Side view of wire mesh tunnel in position in cage. (Dimensions given in centimetres.)

cage by wood strips. The wire mesh tunnel slopes towards the front of the cage and opens by an aperture which is 1 to 2 cm. higher than the maximum diameter of an adult guinea pig (Fig. 2). To operate, the wood tray (Fig. 3) with vertical stop at the rear, is inserted half-way into the tunnel and a guinea pig introduced to the aperture. When the animal has entered—which it will do readily—the tray is pushed fully into the tunnel and raised by inserting plywood strips beneath it. Strips of various thickness can be kept for this purpose: useful sizes are 4, 6 and 10 mm. The slope of the tunnel ensures that the animal's back, on which the mosquitoes feed, is in close contact with the wire mesh, it prevents compression of the thorax and also prevents the animal moving back towards the tunnel entrance. Faeces and urine are deposited in the tray. To remove the guinea pig it is merely necessary to extract the plywood strips (holes can be cut at one end to facilitate this) and withdraw tray and animal. In operation, it requires about 30 seconds to insert the animal and 10 seconds to remove it—and the tray is the only part requiring regular cleaning.

This type of cage has been successfully used for over a year in maintaining laboratory colonies of insecticide-resistant *Anopheles gambiae* Giles and has also been tried successfully with *Aedes aegypti* L.

References

Jones, J. C. and Scheltema, J. L. 1956. An improved guinea pig restrainer. Mosq. News 16: 149.

Nieschulz, O. 1930. Bemerkung über Muckenzucht. Zbl. Bakt. 115:399–400.

Peterson, A. 1955. A manual of entomological techniques. Ann Arbor, Michigan. Pp. 367.

Trembley, H. L. 1955. Mosquito culture techniques and experimental procedures. Am. Mos. Cont. Ass. Bull. 3, pp. 73.

—D. G. Pollard, Jealott's Hill Research Station, Bracknell, Berks., England.

An Improved Diet for Insectary Rearing of *Anopheles quadrimaculatus* Say.—For several years *Anopheles quadrimaculatus* mosquito larvae were reared successfully on powdered dog biscuit following the technique used by Crowell (1940), but at various times trouble developed, due possibly to formula changes in the dog food, and the weak pupae that emerged barely kept the colony alive.

In 1958, through a trial and error screening method in search of a better diet, it was learned that a powdered beef liver extract produced the strongest and healthiest larvae ever reared in the insectary. Some of these larvae had the white stripe down their back that is commonly seen

in natural populations, and the percentage of adults emerging from these pupae compared favorably with the best performance records of the past.

In feeding this diet, a stock solution of liver extract is prepared 24 hours before it is to be used, by adding 20 grams of liver powder * to 1000 cc. of tap water. White enamel pans 12″ x 24″ x 2½″ are used for rearing. In starting a new pan it is first scrubbed with a cleansing powder and rinsed. Then 1000 cc. of tap water and 25 cc. of stock solution are added along with about 3,000 first instar larvae. Each day thereafter an additional 25 cc. of 24-hour old stock solution is added to each pan. On the third day an additional 1000 cc. of tap water is added to each pan and this water level is maintained until the larvae pupate. It has been learned that when the dry liver powder is sprinkled directly into the water in the rearing pans the larvae do not live. Best results have been obtained when a stock solution is prepared 24 hours before it is to be used.

The liver powder is the only food that is given the larvae, but this mixture provides a good medium containing many elements essential for the abundant growth of microorganisms. Although their origin is unknown, all pan cultures are swarming with bacteria and protozoa, with bacilli and *Nassula aureau* being the most abundant. Other bacteria are spirilla and spirochaetes, and other protozoa are *Bursella* (with symbiotic zoochlorella) and *Chilodonella*.

The insectary has been operated successfully for over a year using liver powder exclusively. From the numbers of strong healthy mosquitoes produced, it is evident that this medium with its important supporting microorganisms furnishes the essential food elements needed for good growth and development of *A. quadrimaculatus* mosquito larvae.

Acknowledgments

The authors are indebted to Drs. C. M. Tarzwell and L. G. Williams, Robert A. Taft Sanitary Engineering Center, U. S. Public Health Service, for identifying the bacteria and protozoa and to W. Brown Hawkins for suggesting that liver extract be tested.

Reference

CROWELL, ROBERT L. 1940. Insectary rearing of *Anopheles quadrimaculatus*. Amer. Jour. Hyg. Vol. 32, No. 1, Sec. C, 12–20.

—P. K. Anderson, J. B. Moore, and G. E. Smith, Division of Health and Safety, Tennessee Valley Authority, Wilson Dam, Alabama.

* "Liver Powder N.F." from Nutritional Biochemicals Corporation, Cleveland 28, Ohio—$3.50 per pound.

MUSEUMS IN BOSTON AND CAMBRIDGE

(Get folders at Registration Desk for hours, directions and descriptions.)

Boston

The Institute of Contemporary Art, 230 The Fenway.
Isabella Stewart Gardner Museum, 280 The Fenway.
Museum of Fine Arts, 465 Huntington Avenue.
The Children's Museum, 60 Burroughs St., Jamaica Plain.
The Children's Art Centre, Inc., 36 Rutland Street.
The Museum of Science, Science Park.

(Continued on p. 73)

ASSOCIATION NEWS

PROGRAM*

Sixteenth Annual Meeting

AMERICAN MOSQUITO CONTROL ASSOCIATION

Meeting jointly with the

NORTHEASTERN MOSQUITO CONTROL ASSOCIATION

Somerset Hotel

BOSTON, MASSACHUSETTS

Sunday, March 27, 1960

10:00 A.M. Board Meeting

Registration

Monday Morning, March 28, 1960

8:00 Registration

9:00 Opening Session

Presiding: A. D. Hess, President, American Mosquito Control Association
Addresses of Welcome; Announcements

10:00 Preliminary Business Meeting

10:15 Invitational Papers

Presiding: Hugo Jamnback, President, Northeastern Mosquito Control Association

THE SOVIET UNION AND OTHER EUROPEAN COUNTRIES AS VIEWED BY A MOSQUITO WORKER

Helen Sollers, Plant Pest Control Division, A.R.S., U. S. Department of Agriculture, Washington, D. C.

11:15 TWO DECADES OF PROGRESS AND PERSONALITIES IN MALARIA CONTROL. ARCHIE D. HESS, PRESIDENT, AMERICAN MOSQUITO CONTROL ASSOCIATION.

* See *Program Postscripts* for special notices.

Monday Afternoon, March 28, 1960

12:45–1:30 Northeastern Mosquito Control Association Business Meeting.

PANEL AND PAPERS

Presiding: Vernon Conant, Regional Director, North Atlantic Region, AMCA

1:30 **PANEL: EASTERN ENCEPHALITIS**

Moderator: Richard O. Hayes, CDC, U. S. Public Health Service, Taunton, Massachusetts

A. VIRUS VECTOR RESEARCH. Roy W. Chamberlain, Chief, Virus Vector Research Unit, CDC, U. S. Public Health Service, Montgomery, Alabama.

B. 1959 NEW JERSEY OUTBREAK. Daniel M. Jobbins, New Jersey Agricultural Experiment Station, Rutgers University, New Brunswick, New Jersey.

C. THE IMPORTANCE OF BIRDS AND BIRD MOVEMENT. Donald D. Stamm, Chief, Veterinary Research Unit, CDC, U. S. Public Health Service, Montgomery, Alabama.

D. CONNECTICUT STUDIES ON EASTERN ENCEPHALITIS. Robert C. Wallis, Connecticut Agricultural Experiment Station, New Haven, Connecticut.

E. ENDEMIC VIRUS ACTIVITY IN MASSACHUSETTS. Richard O. Hayes, Taunton, Massachusetts.

Questions and Discussion

Short Recess

3:30 to 5:30 Conference for Trustees and Commissioners. Concurrent with paper reading session. (See Program Postscript §.)

3:40 **SUBMITTED PAPERS**

1. SOME EVIDENCE OF LOCAL ORIGIN OF EEE VIRUS IN CENTRAL FLORIDA. Major Frank G. Favorite, Army Environmental Health Laboratory, Army Chemical Center, Maryland.

2. CURRENT KNOWLEDGE OF EASTERN ENCEPHALITIS IN MARYLAND. W. E. Bickley and R. J. Byrne, University of Maryland, College Park, Maryland.

3. A SENTINEL CHICKEN SHED AND MOSQUITO TRAP FOR USE IN ENCEPHALITIS FIELD STUDIES. M. B. Rainey, G. V. Warren, A. D. Hess, and J. S. Blackmore, CDC, U. S. Public Health Service, Greeley, Colorado.

4. FIELD OBSERVATIONS ON THE RELATION OF *CULEX TARSALIS* POPULATION DENSITIES TO ENCEPHALITIS TRANSMISSION RATES. John S. Blackmore, Louis C. LaMotte, A. D. Hess, Clarence A. Sooter, and Preston Holden, CDC, U. S. Public Health Service, Greeley, Colorado.

5. A MOSQUITO HOST PREFERENCE STUDY MADE WITH REGARD TO EASTERN ENCEPHALITIS IN MASSACHUSETTS. Richard O. Hayes, Taunton, Massachusetts.

6. MOSQUITO SURVEILLANCE AND ABATEMENT AT FT. DIX, NEW JERSEY DURING THE EASTERN EQUINE ENCEPHALITIS OUTBREAK OF 1959. Milton B. Flemings, Irving H. Waller, and Henry Estes, 1st U. S. Army, N. Y. City.

7. STUDIES ON THE BIONOMICS OF *CULEX SALINARIUS* COQ. IN DELAWARE II. HOST ACCEPTABILITY BY ADULT FEMALES. Frank J. Murphy and Richard F. Darsie, Jr., University of Delaware, Newark, Delaware.

8. SOME FACTORS INFLUENCING MOSQUITO LARVAL POPULATIONS IN UTAH. Jay E. Graham, South Salt Lake County Mosquito Abatement District, Iver E. Bradley, University of Utah, and Glen C. Collett, Salt Lake City Mosquito Abatement District, Salt Lake City, Utah.

Monday Evening, March 28, 1960

See Program Postscripts

Tuesday Morning, March 29, 1960

Presiding: Dr. A. D. Hess

8:30 **SYMPOSIUM: MOSQUITO CONTROL OPERATIONS**

Moderator: T. G. Raley, Selma, California.

Subjects will include insecticide barriers, catch basin treatments, granular larvicides, space spraying and fogging, aircraft applications, weed control, water management and wildlife, safety procedures, and ordinances of value in conducting urban mosquito control.

Participants will be Robert L. Armstrong, Superintendent, East Middlesex Mosquito Control Project, Cambridge, Massachusetts; P. Bruce Brockway, Jr., Superintendent, Toledo Area Sanitary District, Toledo, Ohio; Glen C. Collett, Manager, Salt Lake City Mosquito Abatement District, Salt Lake City, Utah; William M. Cox, Director, Galveston County Mosquito Control District, Dickenson, Texas; R. E. Dorer, Director, Bureau of Insect and Rodent Control, Virginia State Department of Health, Norfolk, Virginia; Howard R. Greenfield, Manager-Ent., No. Salinas Valley Mosquito Abatement District, Salinas, California; D. M. Jobbins, Research Specialist in Entomology, New Jersey Agricultural Experiment Station, New Brunswick, New Jersey; W. W. Warner, Director, Monroe County Anti-Mosquito District, Key West, Florida; Franklin C. Wray, Technical Director, Desplaines Valley Mosquito Abatement District, Lyons, Illinois.

10:30 Short Recess

10:40 **SUBMITTED PAPERS**

9. HYDRAULIC DREDGES FOR MOSQUITO CONTROL. Charles W. Blaney, Ellicott Machine Corporation, 1611 Bush Street, Baltimore, Maryland.

10. ESSEX COUNTY MOSQUITO EXTERMINATION COMMISSION'S METHOD OF MIXING INSECTICIDES AND LARVICIDES BY AERATION AND RECIRCULATION. Oliver C. Stivers, Essex County Mosquito Extermination Commission, Verona, New Jersey.

11. AEROPLANE APPLICATION OF GRANULAR PARIS GREEN MOSQUITO LARVICIDE. A. J. Rogers and C. B. Rathburn, Jr., Entomological Research Center, Florida State Board of Health, Vero Beach, Florida.

12. MALATHION FOGGING COMPOSITION FOR USE IN THERMAL AEROSOL DISPERSAL EQUIPMENT. R. D. Vartanian, J. B. O'Neil and R. B. Fortenbaugh, American Cyanamid Company, Princeton, New Jersey.

13. RESIDUAL EFFECTIVENESS OF INSECTICIDES APPLIED IN HOUSES IN TAIWAN, CHINA. P. T. Tseng, Taiwan Provincial Malaria Research Institute, Chao-Chow, Ping-Tung, Taiwan and D. J. Pletsch, Pan American Sanitary Bureau/WHO, Havre 30 (Piso 3), Mexico 6, D. F.

14. RESIDUAL EFFECTIVENESS OF SOME NEW INSECTICIDES AGAINST ADULTS OF *ANOPHELES QUADRIMACULATUS* SAY. G. C. LaBrecque, J. B. Gahan, and H. G. Wilson, Entomology Research Division, ARS, U. S. Department of Agriculture, Orlando, Florida.

15. RESIDUAL EFFECTIVENESS OF SILICA AEROGELS AGAINST MOSQUITOES (LABORATORY STUDIES). Don W. Micks, University of Texas Medical Branch, Galveston, Texas.

Tuesday Afternoon, March 29, 1960

1:30 to 3:30 Conference for Trustees and Commissioners.

Panel and Paper:—

Presiding: William E. Bickley.

1:30 **PANEL: MECHANICS OF MOSQUITO DISPERSAL.**

Participants: R. P. Dow, Greeley, Colorado; B. Hocking, Edmonton, Alberta, Canada; E. T. Nielsen, Vero Beach, Florida; M. W. Provost, Vero Beach, Florida, Chairman.

3:20 16. THE MIGRATORY EXODUS IN SALT-MARSH MOSQUITOES. Maurice W. Provost, Florida State Board of Health, Entomological Research Center, Vero Beach, Florida.

3:30 Final Business Meeting and Election of Officers, AMCA.

Tuesday Evening, March 29, 1960

6:30 Mixer

7:30 Banquet; Toastmaster, Joseph Pannone

Wednesday Morning, March 30, 1960

Presiding: Cdr. John M. Hirst.

8:30 **SPECIAL TOPIC: "INSECTICIDE RESISTANCE IN MOSQUITOES."**

1. SOME PHYSIOLOGICAL ASPECTS OF INSECTICIDE RESISTANCE IN MOSQUITOES. A. S. Perry, CDC, U. S. Public Health Service, Savannah, Georgia.

2. RESISTANCE IN *AEDES* AND *CULEX* MOSQUITOES. William C. McDuffie, Entomology Research Division, A.R.S., U. S. Department of Agriculture, Beltsville, Maryland.

3. PAST, PRESENT AND FUTURE INSECTICIDE RESISTANCE IN MOSQUITOES. A. W. A. Brown, University of Western Ontario, London, Ontario, Canada.

4. DISCUSSION led by C. M. Gjullin, Entomology Research Division, A.R.S., U. S. Department of Agriculture, Corvallis, Oregon.

Short Recess

9:50 **SUBMITTED PAPERS.**

17. SUSCEPTIBILITY LEVELS OF SOME *AEDES AEGYPTI* (LINN.) LARVAE TO DDT AND DIELDRIN. Burton R. Evans, Quarantine Station, U. S. Public Health Service, New Orleans, Louisiana.

18. CROSS-RESISTANCE CHARACTERISTICS OF A MALATHION-RESISTANT STRAIN DEVELOPED IN *AEDES AEGYPTI*. A. W. A. Brown and Z. H. Abedi, University of Western Ontario, London, Ontario, Canada.

19. DISPERSAL OF INSECTICIDES FROM JET-PROPELLED AIRCRAFT. David L. Hayden, U. S. Navy Disease Vector Control Center, U. S. Naval Air Station, Jacksonville 12, Florida.

20. *AEDES AEGYPTI* IN INTERNATIONAL TRAFFIC AREAS. John H. Hughes, U. S. Public Health Service, Washington, D. C.

21. THE SIGNIFICANCE OF WATER HOLDING CAVITIES OF TREES AS MOSQUITO FOCI WITH SPECIAL REFERENCE TO *AEDES AEGYPTI* CONTROL PROGRAMS. John E. Porter, Quarantine Station, U. S. Public Health Service, Miami Beach, Florida; Robert Evans, New Orleans, Louisiana, and John H. Hughes, Foreign Quarantine Division, USPHS, Washington 25, D. C.

22. SOME OBSERVATIONS ON THE ANATOMY OF THE FEMALE REPRODUCTIVE SYSTEM OF *AEDES AEGYPTI* (LINNAEUS). Cyril J. Hodapp, Paul H. Schwartz, and Jack Colvard Jones, University of Maryland, College Park, Maryland.

23. MORE ABOUT *CULEX*. Franklin C. Wray, Desplaines Valley Mosquito Abatement District, Lyons, Illinois.

24. THE CHROMOSOMES OF MOSQUITOES. Osmond P. Breland, University of Texas, Austin, Texas.

Wednesday Afternoon, March 30, 1960

Presiding: D. M. Jobbins.

1:30 **SPECIAL TOPIC: BIOLOGICAL CONTROL.**

Invitational Papers

1. MICROBIOLOGY AND MOSQUITO CONTROL
Marshall Laird, Institute of Parasitology, Macdonald College, Quebec, Canada.

2. CONTROL OF MOSQUITOES WITH PATHOGENIC MICRO-ORGANISMS
William R. Kellen, California Department of Public Health, Fresno, California.

3. DISCUSSION led by B. Hocking, University of Alberta, Edmonton, Alberta, Canada.

2:30 **PANEL: IMPLICATIONS OF INSECTICIDE RESIDUES.**

Moderator: R. L. Vannote, National Advisor, A.M.C.A., Morris Plains, New Jersey.

Participants: W. C. McDuffie, Entomology Research Division, A.R.S., U. S. Department of Agriculture, Beltsville, Maryland; Joseph D. Sherman, C.D.C., U. S. Public Health Service, Savannah, Georgia; John L. George, Fish and Wildlife Service, U. S. Department of Interior, Patuxent Wildlife Research Center, Laurel, Maryland; Donald L. Collins, State Entomologist, New York State Museum and Science Service, Albany, New York.

Short Recess

3:40 **SUBMITTED PAPERS.**

25. THE REGIONAL APPROACH TO MOSQUITO CONTROL FROM THE ECONOMIC AND OTHER STANDPOINTS. Frank J. Bowden, Jr., Delaware Valley Council, Philadelphia, Pennsylvania, and Russell W. Gies, Mosquito Extermination Commission, Media, Pennsylvania.

26. NEWLY RECOGNIZED *AEDES AEGYPTI* PROBLEMS IN MANILA AND BANGKOK. W. McD. Hammon, and Albert Rudnick, Department of Epidemiology and Microbiology, Graduate School of Public Health, University of Pittsburgh, Pittsburgh, Pennsylvania.

27. OBSERVATIONS OF THE DISPERSAL OF *AEDES TAENIORHYNCHUS* IN EXTREME SOUTH FLORIDA AND THE EVERGLADES NATIONAL PARK. Frederick W. Harden, St. Lucie County Mosquito Control, Ft. Pierce, Florida, and Henry S. Chubb, Florida State Board of Health, Jacksonville, Florida.

28. CONTROL OF *CULICOIDES* IN SMALL PLOTS ON CAPE COD. William J. Wall, Jr., Cape Cod Mosquito Control Project, Hyannis, Massachusetts.

29. A REPORT OF A FLIGHT OF *CULEX SALINARIUS* COQ. Harold G. Russell, Jr., District Public Works Office, 5th Naval District, Norfolk, Virginia; John T. Lamb and R. E. Dorer, Virginia State Department of Health, Norfolk, Virginia.

4:50 **INVITATIONAL PAPER.**

A NEW NON-THERMAL INSECTICIDE FOG GENERATOR.

Clyde S. Barnhart, Engineer Research and Development Laboratories, Fort Belvoir, Virginia.

Wednesday Evening

7:00 Board Meeting

PROGRAM POSTSCRIPTS

§ This Program Went to Press on February 9. Additional Details, such as designations of meeting rooms, names of speakers on Monday morning program, and other information not available on this date, will be included on the programs which will be distributed at the meetings.

§ Commissioners' Conference. A room has been reserved for meetings of Trustees and Commissioners for the discussion of mutual problems. Tables will be set up and space provided where representatives from each district may hold conferences with representatives from other districts.

Since this is the first time such a conference room has been available, no formal program has been planned. Future procedures will be dependent upon what is desired by the Trustees and Commissioners at this meeting.

Members should call this conference facility to the attention of interested personnel in this district. Commissioners and Trustees who attend the meetings are urged to take advantage of this opportunity and to arrange for someone from their district to be available at the district table for conferences with interested parties from other districts.

§ An Evening in Boston—Monday Evening: You can have an evening in Boston on your own; or you can stay at the hotel and see some mosquito control motion pictures and slides (7:30 p.m.); or you can join with others and accept an invitation from Carling's to visit their brewery (7:30 p.m., by bus). Information on these and other alternatives, including both educational and entertainment, available at registration desk.

§ Especially for the Ladies: Boston has so much to offer of historical, educational and scientific interest, that many visitors decide what they want to see and do well in advance, and do not wish to go on guided tours. For these individuals there will be someone at or near the registration desk to help you with directions. Most places which you will want to visit are readily accessible by subway, trolley, or bus.

For those who wish to join with others in guided tours, a special tour is being arranged, and there are several others which cover historic and other sites; there is also the "Freedom Trail" in downtown Boston, which can be covered wholly or in part on foot. Information at the registration desk.

NEWS AND NOTES

AUSTIN W. MORRILL, JR.

AMONG THE NEW MEMBERS LISTED ON THE OCCASIONAL INFORMATION SHEET TED RALEY SENDS AROUND we note several who have long been known to mosquito control workers, among them MAJOR MILTON B. FLEMINGS of the First Army Medical Laboratory, FRED J. DANOS of the First Naval District and G. C. LABRECQUE of the Orlando Laboratory of the U. S. Department of Agriculture. Welcome Aboard! And Welcome, too, to you new members whom we don't happen to know but hope to!

Incidentally, we find it of interest, and think you may also, that the list of libraries and schools which find MOSQUITO NEWS essential to maintaining adequate files of scientific periodicals, now stretches around the world, from Australia to Hong Kong to Delhi, India, to Uganda, and even to Moscow and Leningrad. (We were fascinated to discover from these latter listings that the Russian cities run to not less than 164 and 219 postal zones, respectively. Better watch it, New York and Tokyo!)

ALAMEDA COUNTY (CALIF.) STARTED OFF THE NEW YEAR RIGHT according to an article in the San Francisco Chronicle which commenced, "A pretty young Hayward mother showed the Alameda County Board of Supervisors a solution to a sticky housefly problem yesterday." The trouble had started a month earlier, according to the newspaper, when housewives became embattled over hordes of flies invading their homes. They blamed the chicken farmers. The farmers claimed they were innocent. There is no one as innocent as a chicken farmer, particularly one who doesn't clean out from under his cages once in a blue moon and doesn't wash often enough to get the mess wet so the *Hermetia* and rat-tailed maggots can clean it out. Oh . . . the solution the young housewife had? Call in the Mosquito Abatement District. (That's our CHET ROBINSON.)

WHEN DR. STAN FREEBORN RETIRED AS CHANCELLOR OF THE UNIVERSITY OF CALIFORNIA AT DAVIS last July, we thought that by now we would be able to bring you news of his leisurely trip around the world with stopovers at mosquito-important places like Indonesia (where EVERYONE goes) and Africa. However, far from "retiring" as Emeritus Chancellor, Stan has dived back into the academic world of research and teaching from which duty had increasingly called him. In addition to continuing his advisory functions, working with President Kerr of the University on relationships of the University to higher education throughout the state, serving on numerous committees of professional and scientific societies, and all that, Stan has launched a major project to study the flight habits of the western encephalitis mosquito, *Culex tarsalis*.

IN LINE WITH THE RISING INTEREST IN ENCEPHALITIS THROUGHOUT THE COUNTRY, A SYMPOSIUM ON EASTERN EQUINE ENCEPHALITIS WAS HELD BY THE UNIVERSITY OF MARYLAND on 18 November. The symposium included discussion by medical men, veterinarians, epidemiologists, virologists and entomologists, who pointed out that the mortality among humans is between 65 percent and 75 percent. As with other types, the reservoir is thought to be birds, in which the densest incidence of virus occurs, and the likeliest mosquito vector for the Eastern virus is *Aedes sollicitans*, but this remains to be proved.

ROLLIE DORER AND THE *VMCA*'s news sheet *Skeeter* report that the color film the Virginia Association and the Virginia State Health Department produced, which is entitled, "Mosquito Control in Virginia," was shown on TV as a program for a Fifth Grade science class, beamed for the Norfolk city schools but also received in nearby counties. Audience reaction was good and Rollie hopes that similar use may be made of the film in the future. It will also be shown at the CDC-IMCA short course in mosquito control to be held at the Des Plaines Mosquito Abatement District (Illinois) headquarters, 1–5 February, 1960.

RALPH BARR SENDS US WORD OF A REVIEW OF THE GENUS *Culiseta* being undertaken by Dr. N. V. Dobrotworsky of the Zoology Department of the University of Melbourne. Dr. Dobrotworsky would like to receive mosquitoes of this genus in any stage of development and Ralph comments that if all culicidologists (meaning mosquito control types) would cooperate in securing material for projects such as this, it would do much to settle nomenclatural questions *and to stabilize the names of mosquitoes*. Eggs, larvae of all stages, pupae, and adults in alcohol and pinned, are all wanted. They should, of course, be carefully packed. The address of the University of Melbourne is Carleton N.3, Victoria, Australia.

DON PLETSCH, WHO TOLD US ABOUT THE PROGRESS OF THE MALARIA ERADICATION PROGRAM IN MEXICO, as reported in the last issue, sent us a comic book for a New Year's card. It's entitled *"Las Aventuras de Pillín"* with a subtitle, *"Contra el paludismo,"* and a mighty cute and eye-catching affair it is. Besides Pillín's adventures against malaria, the booklet includes a puzzle maze with sideline lessons in malaria control and a cross-word puzzle of the same sort. Don used to be on Taiwan, as you all know, and he adds, "It may be of interest to Mosquito News readers to know that the malaria eradication program in Taiwan has been carried out with such enthusiasm and effectiveness that the final goal is definitely in

sight. In an area with 5,500,000 of the 11,000,000 inhabitants formerly exposed to malaria, the only cases now found (127 in the first semester of 1959) are now limited to 9 small foci with 10,000 inhabitants in total. Extraordinarily active measures are being taken by the national specialists, with WHO and ICA support, to clean up these foci. . . . I am sure they will succeed in the near future."

Travis McNeel Has Retired After "Thirty-Six Years of Most Pleasant Work" which included five years of foreign service in places as far as Manila and as near as Mexico City. Mac and his wife have built a house and settled in Tallulah, Louisiana, where they have long had many friends and kinfolk, and their ranch-type house looks mighty pretty. Alarmingly, Mac said he'd had a heart attack, but adds he's all right now and sent along a picture looking his old, changeless self, to prove it. Happy days, Mac!

Those Who Are Interested in the New Plastic Film Ditch Liners so often mentioned lately by weed control people, will find an excellent and thorough-going article in the December issue *California Vector Views*. Details of preparation of the ditch and laying the 4 mil thick film, are discussed, the rate of installation being given as 80 feet per man-hour. The film is said to last three years.

For Those of Our Readers Who Don't Receive *Vector Views* Regularly, we think we should note also the excellent article by our Dick Peters in the October, 1959, issue of that publication. His subject is "Public Health Vector Control—a Career Opportunity for Entomologists" and, frankly, we didn't know we had it so good, but it sure ought to bring out the neophytes. His conclusion must have sustained Chet Robinson's fainting spirits when he was handed the fly problem so blithely, as we mentioned above. Dick feels, and backs it up, that controllers must move onward to meet the challenge, for the goal is attainable. "Faint heart, say not the way be long. . . ."

Commander Don Murray Spent His Two Weeks Active Military Duty with the Navy Disease Vector Control Center and made himself mighty useful to Capt. Dick Holway and to yours truly, Ye Ed of N and N being in an Allied part of the Navy. Don said that his District (Delta MAD, in Visalia, California) had the driest year in the last 81, which, unfortunately meant *lots* of irrigation, *lots* of catch-basin puddles, and *lots* of backyard headaches.

The Virginia Mosquito Control Association's *Skeeter* Has Also Announced two other notable events. The first, the appointment of Rollie Dorer as project Director for a recently approved National Institutes of Health grant for a survey of Rocky Mountain spotted fever in Virginia, which is planned to determine existing and potential infection in man, animals and environment; and their ecological relationships. The second event: the Annual Meeting of the Association on 23 February, 1960, at the Moose Hall on Rt. 17 south of Portsmouth.

George Thompson Reports on His Late Season Mosquito Populations with a shift from outdoor wild populations to artificial container breeders, mostly *C. quinquefasciatus,* but a reduced *C. salinarius* population staying on. He adds, "In the event some ecologist should read this—does anyone have any idea as to why we have almost no *Anopheles punctipennis* in this area?" Any answers?

California Suffered a Late Fall and Early Winter Drought which Did More than Give Ulcers to the Winter Olympics Committee. It also brought sorrow to the already greyed heads of the Mosquito Abatement Districts all over, and especially in the Northern areas where a single torrent in the middle of September compounded the trouble by washing away all residuals, scooping out new potholes and then leaving behind innumerable puddles and catchbasins for the mosquitoes to enjoy the unseasonably balmy weather which thereupon prevailed for 90 days, until the coming of 1960. From Chet Robinson's Alameda District to John Brawley's Kings County District and Don Murray's Delta District in the south central valley, Managers had a wild scramble trying to carry on control measures normally discontinued by the end of September and still encompass vacation schedules designed to coincide with a "minimum" activity period. It looked downright funny, all these Californians praying for snow!

Our First Person in Who's Who in the AMCA this Month is One of Our Early Members, Lt. Col. Joseph E. Webb, Jr., whose Army career has taken him to a great many places on both sides of both oceans. After graduating from Clemson College, South Carolina, Joe remained a student of fruit insects in the land of peaches, until 1941 when the war ended his nearly ten years of quiet agricultural life and shook him out of the Georgia Department of Entomology and into the middle of a mess of mosquitoes at Camp Blanding, Fla. When the Pacific War began to roar through the Islands, he went out as Chief of the Entomology Section of the 18th Medical General Laboratory and then was brought back at the war's end to be an instructor at the Medical Field Service School, at Ft. Sam Houston in Texas. A tour as consultant to the Far East Command occupation forces in Japan and headquarters in the Philippines, Okinawa & Korea impressed his hosts so much with Joe (and perhaps impressed Joe so much with Japan) that he and his charming

family soon found themselves living in Yokohama where Joe became entomologist for the Headquarters, Eighth Army, until the spring of 1950. A tour at the School at Ft. Sam and then at the Fourth Army Medical Laboratory took up the next three years and was followed by five years in the European theatre, in Germany. Last July, Joe came back to these shores (it's a wonder he recognized them) and has spent the past months at the School at the Walter Reed Army Medical Center in Washington, D. C., before moving on to the Office of the Surgeon General, where he is replacing Col. S. C. Dews upon Sam's retirement from active military duty. Welcome back, Joe!

JOHN R. ARNOLD SAYS HE ISN'T SURE HE STILL QUALIFIES AS A MOSQUITO TYPE BUT WE THINK HE IS. Jack graduated from Fresno State College in 1932 and before that we had seen him energetically chasing down dried fruit and fig insects summertimes at the USDA laboratory there. In 1934 he received his MA from the University of California and in 1938 his Ph.D. was awarded him by Cornell for work in ornithology and economic entomology. From 1938 to 1942 he taught at Stockton Junior College and from 1946 to the present has been a professor, the U. S. Army having taken its customary bite out of his life in the missing interval. He is now Dean of Instruction and pretty busy at it but maintains his connection with the College of the Pacific and as consultant to Les Brumbaugh's North San Joaquin Mosquito Abatement District.

OUR NEXT THREE WHO'S WHO'ERS WERE BORN AT SUCH RECENT DATES THAT I DIDN'T BELIEVE TOM LAURET when he said he was once a member of the *Army* Air Corps. Couldn't be old enough, sez I. Anyway . . . Tom was born in 1927 in Cleveland, Ohio, but grew up in California and went to High School at Fremont High, in Sunnyvale, not far from his present base of operations. In an effort to prove his authentic age he claims this was a pretty rural area then, but shux, so was most of California until about 10 years ago. Tom graduated from San Jose State College after finishing his durance in what is now the Air Force, and although he was stationed at Biloxi, Mississippi, where the Army had one of its worst problems, he was unimpressed. After graduating from college, however, and putting in a year with the Coachella Valley MAD, Tom decided that This was It. He has since been the Assistant Manager of the San Mateo County MAD, under Don Grant's leadership, and is concurrently entomologist of the Mataderos MAD, just to the south.

ERNEST E. LUSK was born in Chico, California, in 1926 and had his collegiate training at Chico State College, receiving his BA in 1951. (He had gone into the Navy upon finishing High School and spent his time as First Class Seaman on a destroyer, no snap.) After graduation from college, Ernie was manager-entomologist of the Los Molinos and Corning MAD's in Tehama County (California) and then spent some time with Chapman Chemical Co. and as a biology teacher in Sacramento. About a year ago the Bureau of Vector Control pirated him from the Department of Education to take Don Green's place (Don, you remember, is in Brazil) in the BVC Sacramento office.

LEON L. HALL, who was entomologist with Les Brumbaugh at the San Joaquin Mosquito Abatement District (California), and is now the entomologist-manager of the new Fresno Westside MAD, was born 35 years ago in Wellsville, Utah. He graduated from Utah State University, where he studied under George Knowlton, and had a most fascinating military career, having entered France and England as a Staff Sergeant in the U. S. Corps of Engineers and emerged as a Lieutenant . . . in the Air Force. This grub to butterfly sort of thing isn't perhaps too astonishing in an entomologist. Afterward, in civilian life, Leon stayed on the ground teaching high school biology and then working on insects connected with alfalfa seed production but soon took to the air with crop spraying and thence into mosquito control. Three years as entomologist for Butte County (California) led to the aforementioned activity in the commencement of the San Joaquin MAD and then to the present District, which is in the lower part of the same valley. Leon is active in the CMCA and helped to originate the annual entomology seminars held by the Association. He was chairman of the entomology committee when the excellent "Guide to the Mosquitoes of California" was published and is presently Chairman of the Insecticide Committee, which is revising "A Guide to the Use of Insecticides in California Mosquito Control."

STUDENTS OF POLITICAL SCIENCE HAVE BEEN POINTING OUT FOR SOME TIME that the reason the countries of West Africa are gaining independence so much faster than those of East Africa is that Europeans can't live in West Africa very comfortably. Now, according to *SCAN*, the Shell Oil Company's Agricultural Newsletter, "The exaltation of the lowly little mosquito to a national symbol has been suggested in Nigeria. Letters to a Lagos newspaper urged Nigeria to put the mosquito in the national flag on the grounds that, without it, independence from Great Britain might not be in the offing in 1960." This calls for an agonizing reappraisal.

IN LINE WITH THE INCREASING AWARENESS OF MOSQUITO ABATEMENT DISTRICTS THAT THEIR PURVIEW EXTENDS BEYOND MERE CONTROL, the San Mateo Mosquito Abatement District and the Lake Mosquito Abatement District (California) have voted funds to match a $20,000 grant from the

State for research on their respective problems with gnats. At the same time, the Southeast Mosquito Abatement District, in the same state, has been selected as the seat for an $8,000 research project by the University of California at Riverside, on a grant from the Los Angeles Flood Control District, for studying tendipedids. The University has also a $15,000 project on *Hippelates*.

The South Cook County Mosquito Abatement District has brought out a small leaflet entitled, "Mosquito Control and Insecticides," which we are sure must be most enlightening and reassuring to the citizens of their District. Among other things, it meets head on the vague fears which have been raised in so many uninformed people's breasts by "popular" magazine articles, so often quoted to us. After laying the facts unemotionally on the line, the questions is asked, "Finally, what is being done to reduce the use of insecticides here—and can I help?" The answer is given: "The SCCMAD has undertaken a 'source reduction' program of water management whereby mosquito producing sites are made unsuited to 'breeding' of these insects." There follows a short discussion of the types of source reduction and the leaflet goes on to describe the actions an ordinary citizen can take to help in water conservation and management and in the maintenance of good ditches and adequate drainage.

Ernestine Thurman Graced Her Old Haunts and Delighted Her Old Friends in Berkeley (California!) back in January, when she visited the Bureau of Vector Control, the Hooper Foundation, the University of California, and others in the Bay Area. She also visited Dr. Stan Freeborn, who has been ill and will have to take a slight raincheck on all those activities we told you about at the start of this column. (He'd appreciate a note from all his friends, we'll bet.) Dr. Thurman interviewed National Institutes of Health grantees, too, and was most pleased and gratified at the condition of all the research projects embraced by that wide program. California was pleased and gratified, too, but sad that Ernestine couldn't stay a bit.

If We Seem to Lean Heavily on California this Issue it's because They're Closest and Our Deadline Got Moved Up but anyway, here are two more little bits. According to our spies, Russ Fontaine is due back in this country in mid-April, after a leisurely trip home via Asia Minor and Europe. We'll nail him for news of *that*. And "Buck" Buchanan has been called to the ICA School in Jamaica, a school which sounds better and better and we wish we could go take a course there at least. (You wonder why THIS is news from California? Well, we got it in California.)

One Last Remark About California and We're Through: Copies of the Field Guide to the Common Mosquitoes of California are still available at $1.00 per copy. Copies may be secured by contacting the Secretary of the California Mosquito Control Association, Don Murray, at the Delta Mosquito Abatement District, Visalia, California. The *Field Guide* has a well-illustrated adult and larval key with all characters clearly pointed to aid the beginning as well as the advanced students in mosquito taxonomy. A distribution chart is included to list the species as to the counties in which they have been collected. Each term used is defined in a simple glossary. There is also a brief biological description of each species, of which there are twenty-five. Sectionalism aside (and we know NO one can accuse us of sectionalism), this little *Guide* is a very handy thing, even for those of other regions who will find it useful on busy, busy days in making quick determinations of genera with which they may not have frequent contact.

In the June, 1959, number of *Mosquito News* we recorded the deaths that same month of Sam Minnich and Will Snow, and mentioned also the deaths of Robert Matheson and Clell Wisecup. In the meantime, friends of these valued members of AMCA have contributed material on them for more detailed notices of their careers and achievements. We have already included articles on Dr. Matheson and Sam Minnich. In the paragraphs below are included appreciative remarks by Gordon Smith for Will Snow, and by Fred Bishopp for Clell Wisecup. Dr. Bishopp has also contributed the information on William I. Fee which follows his remarks about Mr. Wisecup. The present date, March, 1960, may seem a long time to wait to publish a note about Mr. Fee, but his work was of such a pioneering nature that it has a timelessness that renders it appropriate to review it even more than a year late.

WILLIS EVERETT SNOW
1918–1959

Willis Everett Snow died in London, June 12, 1959. He was 40 years of age. Dr. Snow was returning to the States to resume his work with the Tennessee Valley Authority after completing an entomological research project at the East African Virus Research Institute, Entebbe, Uganda. The research project had been made possible through a Fulbright Scholarship.

Dr. Snow was born December 8, 1918, at Chicago, Illinois, and attended high school at Oak Park, Illinois. He studied entomology and botany at the University of Illinois and received his A.B., M.S., and Ph.D. degrees in 1942, 1944 and 1949, respectively.

His professional experience included work as a pest control operator, as an entomologist with the U. S. Public Health Service engaged in malaria control work in war areas, and as teaching assistant at the University of Illinois and at The Principia, Elsah, Illinois. For the ten years preceding his death his outstanding ability and energy had been principally devoted to technical field and laboratory studies on the biology and ecology of the immature and adult stages of mosquitoes and associated organisms as related to the reservoirs of the Tennessee Valley Authority.

For many years he was also actively interested in the ecology of microcosms such as might be found in tree cavities and other plants. His doctoral dissertation, "Arthropods of Wet Tree Holes," is gaining fame as a classic in the field. In pursuit of this interest, he obtained a grant from the Philosophical Society of America and studied the maguey plant in Mexico. As a Fulbright scholar, he was studying the fauna of tree holes and bush-baby nests, as well as the swarming and biting habits of mosquitoes and other Diptera in the dawn and sunset periods. His interest in insects as components of an environment made him an entomologist's entomologist, and his love of field work made him an invaluable source of information about specific habitats.

During his last two years of work for TVA, Dr. Snow published twelve manuscripts. Three more were left incomplete. He was an active member of the Entomological Society of America, the Ecological Society of America, and the American Mosquito Control Association, and was a frequent contributor to *Mosquito News*.

CLELL BURNS WISECUP
1902–1959

Clell Wisecup died in Manhattan, Kansas on February 1, 1959, at the age of 57 years, after a long illness.

He was born July 31, 1902 at Pulaski, Iowa, graduated from Kansas State College with the degree of Bachelor of Science in 1926, and completed graduate work for the M.S. degree at Kansas State in 1928.

He began his professional career in 1928 with the U.S.D.A., Bureau of Entomology, later the Bureau of Entomology and Plant Quarantine. In 1942 he joined the distinguished group of entomologists who comprised the staff of the Orlando laboratory for investigating arthropods of importance to the Armed Forces in World War II. Here he made outstanding contributions to the war effort and to the general public during and since the war, especially in research to develop more effective mosquito control.

From 1946, until his retirement on June 30, 1954, Mr. Wisecup served as Entomologist with the Department of the Army, and played a key role in the development of policies and procedures for post engineers in the supervision and execution of insect and rodent control measures at Army installations. In recognition of his meritorious services, the Secretary of the Army presented him with the "Exceptional Civilian Service Award."

Mr. Wisecup was author or co-author of more than forty papers relating to research, operations, and administration for the control of insects and other pests. He was a member of The American Association for the Advancement of Science, the Entomological Society of America, the Florida Entomological Society, and the American Mosquito Control Association.

William I. Fee
1874–1958

William I. Fee, an outstanding leader in the pioneer fight against mosquitos in Florida was taken from among us on November 11, 1958.

He was born at Galloway Hill, Pennsylvania, April 14, 1874.

Bill Fee, as he was called when I first met him in Fort Pierce in 1924, was a business man there but thoroughly engrossed in the problem of reducing the hordes of mosquitoes. These pests were so abundant in Fort Pierce as to cause many people to refer to the town as Fort Fierce.

Mr. Fee's son, David M. Fee, Sr., who still lives in Fort Pierce, has written me as follows:

"During 1923 a friend came to Dad and told him that he had dug a ditch from a stagnant pool of water on the island to the river. He related how he had watched the little minnows rush in from the river and eat the mosquito larva. This friend came back in a few days and said that all the larvae had disappeared. The friend was Norman Platts, who is known to many members of the American Mosquito Control Association.

"Platts and Dad reasoned that if a system of ditches were dug that provide free access by these minnows to the pools and puddles that were left by the receding high tide, that the mosquitoes might be eliminated.

"They told a lot of the local citizens of their theory. It was not long before this became known as 'Fee's Folly.' "

An organized mosquito control program began to take shape and on September 19, 1925 a St. Lucie County Mosquito Eradication Association was organized with Mr. Fee as Vice President. A mosquito survey was provided for by popular subscription. Twelve thousand dollars was raised in one week, three thousand of which was given by Mr. Fee.

It soon became evident that legislation on mosquito control was necessary and on April 26, 1927 Mr. Fee went to Tallahassee with a proposed Bill prepared by him. This Act empowered any County in the State to form a Sanitary District. He also wrote another bill which he called a "local bill" which taxed the people of St. Lucie County 3 mills to initiate control work.

Through his effective presentation Mr. Fee got these bills through both branches of the Legislature in one evening.

The bill providing for the St. Lucie Sanitary District was signed by Governor John W. Martin on May 11, 1927. The following day the Commissioners of the St. Lucie County Sanitary District met in Mr. Fee's office and set a tax levy of 6 mills.

The people were amazed and perturbed that a tax bill was passed without referendum. Mr. Fee's son relates that "an elderly retired Judge from Kentucky said that Taxation without Representation is treason and that a war had been fought over just such an issue."

Mosquito control work, however, was already begun, because on January 13, 1927 the City of Fort Pierce had started it under the direction of City Manager Smith and City Health Officer Norman Platts. The City promptly turned its work over to the District upon its organization and during 1927 about 54 miles of ditches were dug.

Encouraged by the success of the early work the ditching by hand and by dynamiting went steadily forward.

Mr. Fee continued an active interest in both local and national mosquito control work and was elected President of the Florida State Anti Mosquito Association two successive years. In 1948 the Florida State Anti Mosquito Association presented him with a beautiful watch for "Leadership and Loyal Service."

Mr. Fee's wise counsel and energetic attack on mosquito problems will long be remembered by citizens of St. Lucie County—in fact by many Floridians and residents of other States.

—Fred C. Bishopp

My thanks to Mr. David M. Fee, Sr., and Mr. T. W. Miller, Jr., Director of Lee County Mosquito Control District, Florida, for data regarding Mr. Fee and his work.—F.C.B.

REVIEWS AND ABSTRACTS

HELEN LOUISE DURKEE

THE ANATOMICAL LIFE OF THE MOSQUITO. By R. E. Snodgrass. Smithsonian Misc. Coll. 139(8): 1–87. Publication 4388. Nov. 1959. A copy of this publication has arrived on the eve of Mosquito News' going to press, and I hasten to bring it to the attention of AMCA members.

In 79 pages, Dr. Snodgrass traces the anatomical development of the mosquito, discusses homologies of the parts, and when he considers clarification necessary makes his own interpretation and arrives at "an acceptable" terminology. For this we should be most grateful.

Chapter I, The Larva (37 pages) is divided into 5 sections: the head, the feeding organs, the thorax, the abdomen, and the internal anatomy. Chapter II, The Pupa (14 pages) is composed of 3 sections: the pupal development, the mature pupa, and the pupal metamorphosis. Chapter III, The Adult (32 pages) has essentially the same 5 subdivisions as Chapter I.

The bibliography of 120 references (8 pages) is comprehensive. Dates of publication range from 1855 to 1959; four references are prior to 1900, 10, within the last decade. Dr. Snodgrass has documented his contribution well and has taken care to call attention to papers with good bibliographies.

The text is written as only a master of his subject *can* write—simply, authoritatively, and with a sparkling style that sustains interest to the very last word. Every page is brimful of information. Other insects, as well as the biological and physiological aspects are discussed only insofar as they relate to, or are necessary to clarify or explain, structural adaptation or modification in the mosquito. Illustrations are ample, with every drawing clearly labeled and pleasing to study.

The following excerpts from the text illustrate the scope and tenor of the monograph:

From the Introduction—"It is commonly said that the larva is metamorphosed into the adult during the pupal stage. Actually it simply returns to its parental adult structure after having undergone during its evolutionary history a metamorphosis by which it took on a form and structure suited to a way of living quite different from that of its parents."

From the Feeding Organs of the Larva—"The insect mouth parts, therefore, are all *outside* the mouth; the space between them may be termed the *preoral food cavity,* but by a long-perpetuated error it has commonly been called the 'pharynx.' For want of a revised nomenclature we still speak of the upper wall of the preoral cavity as the *epipharyngeal surface,* and call the tongue-like lobe that projects below the mouth the *hypopharynx.* This is just a part of our heritage from the early insect anatomists, who had only vertebrate names to draw from, and applied them to insects on a functional rather than a morphological basis."

Under Internal Anatomy of the Pupa—"The insect larva has no idea of the meaning of its life or of what is to become of it. The hereditary factors automatically determine its destiny by converting it into a pupa and finally into an adult. Yet physiologically, the larva is loaded with responsibilities. Not only must it maintain its own existence, but at the same time it must provide for the future nutritional needs of the pupa and for its transformation to the adult. In the mosquito pupa there is a minimal breakdown of larval tissues to furnish food for the developing adult organs."

In Pupal Metamorphosis—"The mosquito pupa breaks with the tradition that a pupa is a 'resting stage' in the life of the insect. When an ordinary pupa is broken open it is seen to be full of a creamy mass of soft material resulting from the disintegration of the larval tissues. The inside of a mosquito pupa is as clean as that of the larva or the adult, and the organs appear to be intact."

From the Adult—"The newly emerged mosquito is really an elegant insect as it stands high on its long slender legs, the abdomen held straight back beneath the neatly folded wings, and the long proboscis extended from the head. A remarkable thing about the mosquito is that, after the whole previous life spent in the water, on emergence from the pupa it is at once at home in the air. Without a flutter of the wings or any practice trial, it makes a perfect takeoff, flight, and distant landing. During the pupal stage, therefore, the mosquito has not only been equipped with a complete mechanical apparatus of flight, but in its nervous system a mechanism of control has been fully elaborated."

It is a fascinating account of the anatomical life of the mosquito. Novice and seasoned investigator alike will profit from a careful reading.—H. L. Trembley Durkee.

A SYNOPTIC CATALOG OF THE MOSQUITOES OF THE WORLD. By A. Stone, K. L. Knight, and H. Starcke. Thomas Say Foundation, Vol. VI, 358 pp., 1959. Published by the Entomological Society of America, Washington, D. C. Prices: $6.50 to ESA members; $7.25 to non-members. This work is an up-to-date version of Edwards' mosquito catalog published in 1932 as Fascicle 194 of *Genera Insectorum.* It was supported in part by a transfer of funds from the Office of Naval Research to the Smithsonian Institution.

The catalog includes all generic, subgeneric, and trivial names applicable to mosquitoes published prior to 1959, including the citation to the original description for each. In the first two categories the genotype and the method by which it achieved this status is cited. Each specific and infraspecific name is accompanied by information about the location and life-history stages of the holotype or of syntypes and the type locality. For

each valid trivial name those references are cited which most adequately present information on life-history stages, biology, or vector relationships not available in the original citation. References to nomenclatural matters are given in some cases, and distribution in broad terms appears for each valid species, subspecies, and variety.

The volume includes 111 valid genera and subgenera and 2247 valid species. There are 339 names of the genus group and 4068 of the species group, exclusive of the *nomina nuda.* No new names are proposed.

This reviewer, having had a brief association with mosquito systematics in the past and a first-hand knowledge of this catalog as editor, can attest to the care with which this thorough-going work was prepared. It is indispensable for everyone who concerns himself with mosquitoes in any way.—Richard H. Foote, Entomology Research Division, ARS, U. S. Department of Agriculture, Washington, D. C.

Malaria Surveillance in the United States, 1958. By Brody, J. A. and Dunn, F. L. Amer. J. Trop. Med. Hyg. 8(6):635–639. 1959. Ninety-four cases of malaria were reported to the Communicable Disease Center during 1958 from 23 states and Hawaii. Confirmed and presumptive cases numbered 72. Of these 65 were of foreign origin. Thirty-three of these cases were in military personnel, the majority contracting their disease in eastern Asia (Korea 9, Philippines 9). A total of 32 civilian cases of foreign origin came from 17 different nations. Mexico with 7 cases still leads the list although the numbers of cases acquired in Mexico has been dropping rapidly in recent years. The malaria eradication campaign in Mexico is considered to be a major factor in this decline.

Only 3 naturally acquired indigenous cases were reported—one from California, one from Arizona, and one from Pennsylvania. The actual places of origin of these cases could not be determined and no associated cases or endemic foci were found.

Four cases apparently resulting from blood transfusions were reported. A blood donor in one of these cases was identified as having a silent *P. malariae* infection, implying that, in 1958, the risk of acquiring malaria in the United States was greater from blood transfusions that from natural causes. The occurrence of these transfusion-acquired cases suggests the possibility that there may be numerous silent malaria infections in this country. These silent parasitemias do not, however, appear to be an important source of plasmodia capable of introducing the infection into the mosquito population and creating endemic foci.

As long as malaria prevails in other parts of the world, the threat of malaria outbreaks in the United States remains. Anopheline mosquitoes are abundant and their opportunities for survival increase with the increasing amount of land under irrigation. Only through careful surveillance of malaria and investigation of each reported case with the promptness and vigor customary in the investigation of smallpox or plague can we preserve the near freedom from malaria we are currently enjoying.—Authors' summary and conclusions.

MUSEUMS IN BOSTON AND CAMBRIDGE

(Continued from p. 58)

Cambridge

Harvard—Fogg Art Museum, Quincy Street and Broadway.
Busch-Reisinger Museum of Germanic Culture, Kirkland Street and Divinity Avenue.
Museum of Comparative Zoology, Oxford Street.
Mineralogical Museum, Oxford Street.
Botanical Museum, Oxford Street.
Geological Museum, Oxford Street.
Semitic Museum, Divinity Avenue.
Peabody Museum of Archaeology and Ethnology, Divinity Avenue.

Massachusetts Institute of Technology, Massachusetts Avenue.

REFERENCES TO LITERATURE OF INTEREST TO MOSQUITO WORKERS AND MALARIOLOGISTS

HELEN SOLLERS

Plant Pest Control Division, Agricultural Research Service, United States Department of Agriculture

ADULTICIDES AND LARVICIDES

BRITZ, L. 1958. Beispiele aus der praxis der freilandstechmücken-bekämpfung (Diptera, Culicidae). Deut. Gesell. f. Angew. Ent. Verhandl. 14:46–54. [East Germany.]

BUCHMANN, W. 1959. Bekämpfung der stechmücken. Prakt. Schädlingsbekämpfer 11(3):29. [*Anopheles, Culex, Aedes, Mansonia.*]

———. 1959. Erfahrungen über die durchführung und organisation von stechmückenbekämpfungsaktionen. Prakt. Chemie 10(5):183–186, 189. [*Culex, Aedes* et al.]

COLONIAL OFFICE. 1958. Colonial research 1957–1958. Colonial pesticides research committee. Eleventh annual report (1957–1958) [W. J. Hall, Chairman] (pp. 207–227). 347 pp., London. [Includes mosquitoes.]

ESKENDEROV, G. A. 1959. Results of malaria control in the city of Derbent of the Dagestan ASSR. Med. Parazit. i Parazit. Bolezni 28(5): 540–542. In Rus.

FAY, R. W. 1959. Toxic effects of boron trioxide against immature stages of *Aedes aegypti, Anopheles quadrimaculatus,* and *Culex quinquefasciatus.* Jour. Econ. Ent. 52(5): 1027–1028.

FEHN, C. F., CARMICHAEL, G. T., ELMORE, C. M., JR. and TAYLOR, J. W. 1959. Operational experiences with paris green pellets in mosquito control. Mosquito News 19(4):238–243.

GRITSAY, M. K. and SHEVCHENKO, A. K. 1959. The results of malaria control in the Ukranian SSR during 40 years of Soviet power. Med. Parazit. i Parazit. Bolezni 28(5):523–527. In Rus.

LEGRIS, G. 1959. Winnipeg cuts mosquito breeding with winter aerial spraying. Pest Control 27(9):22, 24.

REHM, W. F. and GARMS, R. 1959. Zur wirkung von Alodan auf stechmücken. Ztschr. f. Tropenmed. u. Parasitol. 10(2):154–159. Engl. Sum. [*Anopheles, Culex.*]

SOEIRO, A. 1958. The Institute for Medical Research of Mozambique. Inst. de Med. Trop. An. (Lisboa) 15(Suppl. 1):400–414. [Mosquito control.]

VARIOUS TYPES OF CONTROL

ALAMEDA COUNTY MOSQUITO ABATEMENT DISTRICT. 1959. Twenty-eighth annual report 1958. 9 pp., California.

DAVIS, A. N., GAHAN, J. B., WEIDHAAS, D. E. and SMITH, C. N. 1959. Exploratory studies on gamma radiation for the sterilization and control of *Anopheles quadrimaculatus.* Jour. Econ. Ent. 52(5):868–870.

PARASITES AND PREDATORS

LAC, J. 1959. Bewertung der bedeutung von amphibien vom standpunkt der mückenbekämpfung auf der Schütt-Insel (Zitný Ostrov, Südslowakei). Biologia (Bratislava) 14(4):265–272. In Czech.

SHEMANCHUK, J. A. 1959. Note on *Coelomomyces psorophorae* Couch, a fungus parasitic on mosquito larvae. Canad. Ent. 19(11):743–744. [Found on *Culiseta inornata.*]

ATTRACTANTS AND REPELLENTS

DWORKIN, Z. Z. 1959. New attitudes toward insect repellency. Soap and Chem. Spec. 35(2): 77, 79, 81, 83.

NABOKOV, V. A. and BATAEV, P. S. 1959. Status of mosquito repellent study. Zhur. Mikrobiol. Epidemiol. i Immunobiol. (Moskva) 30(6): 44–48. In Rus. [This journal also available in English translation as Jour. Microbiol. Epidemiol. and Immunol.]

RAKHMANOVA, P. I. 1959. Methods of primary selection of repellent preparations against bloodsucking mosquitoes with laboratory tests on animals. Med. Parazit. i Parazit. Bolezni 28(5): 620–621. In Rus.

RESISTANCE AND SUSCEPTIBILITY

DAVIDSON, G. 1959. The inheritance of resistance to insecticides in anopheline mosquitoes. Internatl. Cong. Zool. Proc. 15:504–505.

DERBENEVA-UKHOVA, V. P. 1959. Resistance of carriers to insecticides according to materials of the World Health Organization. Med. Parazit. i Parazit. Bolezni 28(6):737–741. In Rus.

GÖKBERK, C. 1958. Resistance to insecticides and test results of anophelines in Turkey. Türk Ijiyen ve Tecrübî Biyoloji Dergisi (Ankara) 18 (2/3):282–293. In Turk., Engl. Sum.

HAMON, J. and COWORKERS. 1959. Observations sur le niveau de sensibilité aux insecticides de quelques moustiques du littoral Méditerranéen. Présence d'une souche de *Culex pipiens* L. résistante au dieldrin. Soc. de Path. Exot. Bul. 52 (2):199–208.

KLEIN, J. M. and MICHEL, R. 1959. Observations sur le niveau de sensibilité aux insecticides des larves de l'*Aedes (Ochlerotatus) detritus* (Haliday), 1833 du littoral Méditerranéen. Soc. de Path. Exot. Bul. 52(3):295–299.

LEWALLEN, L. L. and NICHOLSON, L. M. 1959. Malathion metabolism in larvae of resistant mosquito strains. Ent. Soc. Amer. Ann. 52(6):767.

Mathis, W. Schoof, H. F. and Fay, R. W. 1959. Method for the field determination of susceptibility levels of adult mosquitoes. Mosquito News 19(4):255.

Narasimhan, D., Karani, N. D. P. and Krishnaswami, P. 1959. Field survey of insecticide susceptibility of disease vectors. Part IA. *Anopheles culicifacies* in Poona. Indian Jour. Pub. Health 3(2):160–168.

Perry, A. S. 1959. Investigations on the mechanism of DDT resistance in certain anopheline mosquitoes. WHO/Mal/244, WHO/Insect./101, 24 pp.

Steyn, J. J. and Coworkers. 1959. Possible simplified gravidity technique for detecting physiological resistance of *Anopheles gambiae* to BHC. S. Afr. Med. Jour. 33(9):172.

Yaguzhinskaya, L. V. 1959. Resistance mechanism in insects (according to the World Health Organization). Med. Parazit. i Parazit. Bolezni 28(5):609–615. In Rus. [Includes mosquitoes.]

INSECTICIDES AND CHEMICALS

Negherbon, W. O. 1959. Handbook of toxicology. III. Insecticides: a compendium. U.S.A.F. Wright Air Developm. Cent. Tech. Rpt. 55–16 (Vol. III):1–854.

Reid, J. A. and Lim, C. S. 1959. A note on the residual life of the insecticide malathion. Med. Jour. Malaya 13(3):239–242.

Seidel, E. 1958. Gefährdung von mensch und haustier durch kontakinsektizide auf DDT-, HCH-, und PE-basis. Berlin u. Münch. Tierärztl. Wchnschr. 71(1):3–5; (2):26–29; (3):50–53. [Engl Sum. in last one.]

Soap and Chemical Specialties. 1959. Aerosol insecticides storage test. Tentative official method of the Chemical Specialties Manufacturers Association for storage of aerosol insecticides. Soap and Chem. Spec. Blue Book, pp. 223–224.

———. 1959. Aerosol test method for flying insects. Official method of the Chemical Specialties Manufacturers Association for assaying aerosols for flying insects. Soap and Chem. Spec. Blue Book, pp. 225–226.

West, T. F. 1959. The history of the African pyrethrum industry. Roy. Soc. Arts. Jour. 107 (5034):423–441.

Yeomans, A. H. and Fulton, R. A. 1959. Evaluation of spray deposits and inhalation particles from aerosol sprays. Aerosol Age 4(7): 22–23, 70.

TOXICOLOGY

González, A. 1959. Parathion. Retiro Azucarero 5:5. [Toxicity to man.]

Shirakawa, M. 1959. Experimental studies on the toxicity of benzene hexachloride (BHC). IV. Effects of lindane vapor to insects and mammals. Kurume Med. Jour. 5(4):230–244.

Toivonen, T., Ohela, K. and Kaipainen, W. J. 1959. Parathion poisoning—increasing frequency in Finland. Lancet 2(7095):175–176.

BIOLOGY AND ECOLOGY

Brygoo, E. R., Dodin, A. and Sureau, P. 1959. Repas sanguin de *Culex fatigans* sur *Chamaeleo*. Inst. Pasteur Madagascar Arch. 27:63–68.

Brygoo, E. R., Sureau, P. and Dodin, A. 1959. Survie des *Culex fatigans* gorgés sur *Chamaeleo* parasité par *Foleyella furcata*. Inst. Pasteur Madagascar Arch. 27:63–68.

Chapman, H. C. 1959. Overwintering larval populations of *Culex erythrothorax* in Nevada. Mosquito News 19(4):244–246.

Collignon, E. 1959. Observations biologiques sur les *Anophèles* de la région d'Alger (1932–1956). Inst. Pasteur d'Algerie Arch. 37(2):263–285.

Dodin, A. and Brygoo, E. R. 1959. La thiamine n'empêche pas *Culex fatigans* de se nourrir sur *Chamaeleo*. Inst. Pasteur Madagascar Arch. 27:69–70.

Galliard, H. 1959. Biologie des culicides du genre *Mansonioides* en Asie orientale: leur importance comme vecteurs de parasites. Internatl. Cong. Zool. Proc. 15:694–697.

Gillett, J. D., Corbet, P. S. and Haddow, A. J. 1959. Observations on the oviposition-cycle of *Aedes (Stegomyia) aegypti* (Linnaeus), III. Ann. Trop. Med. and Parasitol. 53(2):132–136.

Goma, L. K. H. 1959. Periodic pupation in *Anopheles gambiae* Giles. Ent. Soc. South. Afr. Jour. 22(1):275–276.

Haddow, A. J., Gillett, J. D. and Corbet, P. S. 1959. Laboratory observations on pupation and emergence in the mosquito *Aedes (Stegomyia) aegypti* (Linnaeus). Ann. Trop. Med. and Parasitol. 53(2):123–131.

Kamura, T. 1959. Studies on the *Culex pipiens* group of Japan. 4. Ecological studies on the Nagasaki *molestus*. Endemic Dis. Bul. (Nagasaki Univ.) 1(1):51–59. Engl. Sum.

Külhorn, F. 1958. Über die milieuverhältnisse oberbayerischer brutgewässer von *Theobaldia alaskaensis* Ludlow (Dipt., Culicidae). Nachrbl. de Bayer. Ent. 7(5):41–45. [*Culiseta*.]

———. 1958. Untersuchungen über die ernährung der larven von *Anopheles bifurcatus* Meigen (Dipt. Culicidae). Nachrbl. der Bayer. Ent. 7(12):118–124.

Nakao, S. 1959. Ecological studies on the community of adult mosquitoes resting in the grass in the daytime. I. An analysis of dynamic structure. III. Resting habits of some mosquitoes. Jap. Jour. Sanit. Zool. 10(1):1–7; 8–15. In Jap., Engl. Sum.

Rachou, R. G., Moura Lima, M., Ferreira Neto, J. A. and Martins, C. M. 1958. Alguns dados sôbre o comportamento de mosquitos de Ponta Grossa (Florianópolis, Santa Catarina). Rev. Brasil. de Malariol. 10(4):417–427. Engl. Sum.

Shu, K. H., Chen, Y. L. and Tao, X. K. 1959. Observations on the hibernation of the common mosquitoes in Szechuan. Acta Ent. Sinica 9(2):201. In Chin.

Tan, C. H., Li, L. C., Shih, K. M. and Luh, P. L. 1959. A preliminary study on the gono-

trophic rhythm and cycle of *Anopheles hyrcanus sinensis* Wiedemann, 1828 (Diptera, Culicidae). Acta Zool. Sinica 11(1):67–73. In Chin., Engl. Sum.

TUNG, B. 1959. Preliminary observation on the hibernation of *Culex pipiens pallens* in Tsinan. Acta Ent. Sinica 9(2):190–194. In Chin., Engl. Sum.

VELOSO, H. P. 1958. Considerações gerais sôbre os biótopos e habitats dos anofelíneos do sub-genero *Kerteszia*. Inst. Oswaldo Cruz Mem. 56(1):163–179. Engl. Sum.

WEBB, J. E., JR., BARTON, J. B., LINTS, R. C. and SHEPHERD, E. L. 1959. Observations on *Culiseta morsitans* in the Landstuhl/Pfalz area of Germany 1956–59. Mosquito News 19(4):267–269.

ZALUTSKAYA, L. I. 1959. Comparative data on the biology of *Anopheles minimus* and *Anopheles vagus* in the environs of the city of Tay-Nguen (Democratic Republic of Vietnam). Med. Parazit. i Parazit. Bolezni 28(5):548–553. In Rus., Engl. Sum.

GENETICS

PAL, R. and KRISHNAMURTHY, B. S. 1959. Induced mutations of X-ray irradiations in *Culex fatigans* Wied. (1828). Nature (London) 184 (4686):658.

BEHAVIOR

COLLESS, D. H. 1959. Notes on the culicine mosquitoes of Singapore. VI.—Observations on catches made and unbaited trap-nets. VII.—Host preferences in relation to transmission of disease. Ann. Trop. Med. and Parasitol. 53(3):251–258; 259–267.

LAARMAN, J. J. 1959. Host-seeking behaviour of malaria mosquitoes. Internatl. Cong. Zool. Proc. 15:648–649.

LAVOIPIERRE, M. M. J. 1959. Some observations on the biting cycle of the Liverpool strain of *Aedes aegypti* var. *queenslandensis*. Roy. Soc. Trop. Med. and Hyg. Trans. 53(4):307.

LU, H. C., HSIAO, S. M. and YUAN, Y. C. 1959. Obervations on swarming and mating of *Culex pipiens* var. *pallens* Coquillett in Nanking. Chinese Med. Jour. 78(3):281.

LU, H. C. and YU, Y. 1959. Observations on resting places and activities of *Culex pipiens* var. *pallens* Coq. in Southern Shantung Province. Chinese Med. Jour. 78(2):181.

LU, S. C., MA, T. C. and LEE, C. P. 1959. The blood preference of some culicine mosquitoes in rural areas of Nanking. Acta Ent. Sinica 9(2): 178–182. In Chin., Engl. Sum.

ROOT, O. M. 1958. Individual host discrimination by blood-sucking insects. Bombay Nat. Hist. Soc. Jour. 55(2):376. [Mainly mosquitoes.]

SICART, M. and ESCANDE, F. 1958. Sur le comportement nocturene de quelques larves de culicides. Soc. d'Hist. Nat. Bul. (Toulouse) 93(1–2):45–47.

ANATOMY, MORPHOLOGY AND PHYSIOLOGY

BERTRAM, D. S. 1959. Course in advanced entomological techniques applied to malaria eradication. IV. The ovary and ovarioles of mosquitoes (an allustrated note, with glossary). WHO/Mal/ 238:170–186.

DETINOVA, T. S. 1959. Course in advanced entomological techniques applied to malaria eradication. III. Lectures on age-grouping methods in Diptera of medical importance. WHO/Mal/238: 5–169. Illus.

GIGLIOLI, M. E. C. 1959. Observations on the structure of the ovariole and the follicular residue body or corpus luteum in *Anopheles gambiae*. Roy. Soc. Trop. Med. and Hyg. Trans. 53(4): 310–311.

KAMURA, T. 1959. Studies on the *Culex pipiens* group of Japan. 5. Morphological studies on the Nagasaki *molestus*. Endemic Dis. Bul. (Nagasaki Univ.) 1(2):176–185. Engl. Sum.

——— and BEKKU, H. 1957. Studies on the *Culex pipiens* group of Japan. 2. Morphological studies of Minamata *pallens*. Nagasaki Igakkai Zassi 32(11):1451–1455.

KHATENESYAN, T. A. 1959. Survival of the mosquito *Anopheles bifurcatus* until reaching an epidemiological dangerous age in the Batum district of the Adzhar ACCR. Med. Parazit. i Parazit. Bolezni 28(5):560–561. In Rus.

KOZHEVNIKOVA, S. M. 1959. Age groups and epidemiological importance of the mosquito *Anopheles maculipennis* near Stalingrad for a succession of years. Med. Parazit. i Parazit. Bolezni 28(5): 555–560. In Rus., Engl. Sum.

LUKASIAK, J. 1957. Morphological variability of eggs and of the scale index in *Anopheles maculipennis* Meig., 1818. Acta Parasitol. Polonica (Warsaw) 5(27):599–612. In Pol., Engl. Sum.

PETERS, W. 1959. Albinism in mosquitoes of the *Anopheles punctulatus* group. Austral. Jour. Sci. 21(9):304–305.

ROSAY, B. 1959. Expansion of eggs of *Culex tarsalis* Coquillett and *Aedes nigromaculis* (Ludlow) (Diptera:Culicidae). Mosquito News 19 (4):270–273.

SAMARAWICKREMA, W. A. 1959. Formation of corpora lutea in *Mansonioides* females following (a) normal oviposition, (b) degeneration of follicles. Roy. Soc. Trop. Med. and Hyg. Trans. 53(4):305–306.

WALLIS, R. C. 1959. Diapause and fat body formation by *Culex restuans* Theobald (Diptera, Culicidae). Ent. Soc. Wash. Proc. 61(5):219–222.

WHARTON, R. H. 1959. Age determination in *Mansonioides* mosquitoes. Nature (London) 184 (4689):830–831.

TECHNIQUES

BREŽNER, J., HART, R. A. and ENNS, W. R. 1959. A simple method *in vitro* storage of insect haemolymph. Kansas Ent. Soc. Jour. 32(2): 92–94.

BURGESS, L. 1959. Techniques to give better hatches of the eggs of *Aedes aegypti* (L.) (Diptera:Culicidae) Mosquito News 19(4):256–259.

GILLIES, M. T. 1958. A simple autoradiographic method for distinguishing insects labelled with phosphorus-32 and sulfur-35. Nature (London) 182 (4650):1683–1684.

KAHLAF, K. T. 1959. The electron microscope as an instrument in insect taxonomy. Kansas Ent. Soc. Jour. 32(2):94–96.

LENNOX, E. K. 1959. A versatile mosquito rearing cage. Mosquito News 19(4):280–282. Illus.

LIEN, J. 1959. Laboratory culture of *Aedes togoi* and measurements of its susceptibility to insecticides. Roy. Soc. Trop. Med. and Hyg. Trans. 53(4):305.

LILJEDAHL, L. A. and STRAIT, J. 1959. Spray deposits measured rapidly. Agr. Engineering 40 (6):332–335.

LOOMIS, E. C. and SHERMAN, E. J. 1959. Comparison of artificial shelters and light traps for measurement of *Culex tarsalis* and *Anopheles freeborni* populations. Mosquito News 19(4):232–237.

MACDONALD, G. 1959. Course in advanced entomological techniques applied to malaria eradication. II. Introduction. WHO/Mal/238:3–4.

MACGUIRE, B., JR. 1959. Passive overland transport of small aquatic organisms. Ecology 40(2): 312.

MASTERS, C. O. 1959. Mass production of mosquito larvae. Mosquito News 19(4):280.

OTA, E. 1959. An adsorption chromatography of dieldrin with a colour indicator. Botyu-Kagaku 24(1):26–30.

PORTERFIELD, J. S. 1959. A simple tissue culture technique for the detection of yellow fever antibodies. Roy. Soc. Trop. Med. and Hyg. Trans. 53(4):310.

REEVES, W. C. and RENTELN, H. A. 1959. Determination of mosquito attack rates by interview of Kern County, California residents. Mosquito News 19(4):274–279.

SCHMIDT, C. H. and WEIDHAAS, D. E. 1959. Effect of varying conditions in a laboratory testing technique on the mortality of mosquito larvae. Jour. Econ. Ent. 52(5):977–979.

SOAP AND CHEMICAL SPECIALTIES. 1959. Tentative method for internal pressure determination of aerosol products in lightweight containers. Soap and Chem. Spec. Blue Book, pp. 228, 259, 260.

STANILAND, L. N. 1959. Fluorescent tracer techniques for the study of spray and dust deposits. Jour. Agr. Engin. Res. 4(2):110–125.

TARSHIS, I. B. 1959. Feeding *Culex tarsalis* on outdated whole human blood through animal-derived membranes (Diptera:Culicidae). Ent. Soc. Amer. Ann. 52(6):681–687.

UNGUREANU, E., CRISMARU, V. and BURGHELE, E. 1959. Investigations on the contact of the legs of mosquitoes with resting surfaces and its relationship with DDT and dieldrin intoxication. WHO/Mal/243, 9 pp.

VOSTAL, Z. 1958. Two simple methods of entomologic examination of the activity of emulsions and suspensions of contact insecticides. Ceskoslov. Epidemiol. 7(5):344–348.

WORLD HEALTH ORGANIZATION. 1959. Course in advanced entomological techniques applied to malaria eradication (London, April 1959). WHO/Mal/238, 187 pp. [L. J. Bruce-Chwatt, editor.] See also Detinova and Bertram under Anatomy, Morphology and Physiology.

TAXONOMY

ANWIKAR, A. K. 1959. Studies on the mosquitoes of Nagpur. I. Identification and bionomics of the true mosquitoes. Zool. Soc. Coll. Sci. Nagpur Bul. 2:63–72.

BRANCH, N. and SEABROOK, E. L. 1959. *Culex (Culex) scimitar,* a new species of mosquito from the Bahama Islands (Diptera, Culicidae). Ent. Soc. Wash. Proc. 61(5):216–218.

COLLESS, D. H. 1959. Notes on the culicine mosquitoes of Singapore. V. The *Aedes niveus* subgroup (Diptera, Culicidae): previously described species and keys to adults and larvae. Ann. Trop. Med. and Parasitol. 53(2):166–179.

———. 1959. Undescribed head hairs in larvae of the genus *Culex* (Diptera:Culicidae). Roy. Ent. Soc. London Proc. Ser. B. 28(7–8):114.

DOBROTWORSKY, N. V. 1959. Notes on Australian mosquitoes (Diptera, Culicidae). IV. *Aedes alboannulatus* complex in Victoria. Linn. Soc. N. S. Wales Proc. 84(389):131–145.

HAMON, J. and ADAM, J. P. 1959. Description de deux nouveaux *Aedes* de Cote-d'Ivoire appartenant au sous-genre *Aedimorphus: A. ovazzai* sp. n. et *A. rickenbachii* sp. n. Soc. de Path. Exot. Bul. 52(2):147–154.

HEDEEN, R. A. 1959. Taxonomical studies on the larvae of the genus *Psorophora* in the United States with particular reference to the common species of the subgenus *Grabhamia* (Diptera:Culicidae). Ent. Soc. Amer. Ann. 52(6):668–674.

LIU, L. C., FANG, C. C. and HU, M. H. 1959. Study on the forms of *Anopheles minimus* Theobald, 1901. Acta Ent. Sinica 9(2):154–160. In Chin., Engl. Sum.

MARKS, E. N. 1959. The subgenus *Ochlerotatus* in the Australian region (Diptera:Culicidae). II. Five new species from Western Australia. Queensland Univ. Dept. Ent. Papers 1(8):111–134. [*Aedes hodgkini, macintoshi, ratcliffei, hesperonotius,* and *purpureifemur* all sp. n.]

——— and HODGKIN, E. P. 1958. A new species of *Aedes (Finlaya)* from northern Australia (Diptera, Culicidae). Linn. Soc. N. S. Wales Proc. 88(386):33–39. [*A. britteni* n. sp.]

MARTINS, C. M. 1958. Do diagnóstico diferencial específico entre o *Anopheles (Kerteszia) cruzii cruzii* e o *Anopheles (Kerteszia) homunculus* pelos caracteres dos adultos fêmeas (Diptera, Culicidae). Rev. Brasil. de Malariol. 10(4):429–430. Engl. Sum.

MUSPRATT, J. 1959. Research on South African Culicini (Diptera:Culicidae). V. A new species

of and notes on the sub-genus *Mucidus,* with other observations and records. Ent. Soc. South. Afr. Jour. 22(1):64–67. [*Aedes lucianus.*]

NAKATA, G. 1959. Redescription of *Aedes (Finlaya) kobayashii* Nakata, 1956. Jap. Jour. Sanit. Zool. 10(1):16–20.

RAGEAU, J. and VERVENT, G. 1959. Le genre *Taeniorhynchus* (Diptera, Culicidae) en Nouvelle-Calédonie et aux Nouvelles-Hébrides. Soc. de Path. Exot. Bul. 52(3):358–366. [*Mansonia*]

RUFFIÉ, J. 1958. Étude bio-systématique des Culicinae du sous-bassin aquitain. Soc. d'Hist. Nat. Bul. (Toulouse) 93(1–2):133–224.

SAKAKIBARA, M. 1959. On *Anopheles (Anopheles) omorii* n. sp. Endemic Dis. Bul. (Nagasaki Univ.) 1(3):288–295. In Engl.

SERVICE, M. W. 1959. A detailed examination of *A. funestus funestus* from Southern and Northern Nigeria. (A summary with notes on its varieties and synonyms). WHO/Mal/245, 6 pp.

———. 1959. A new culicine mosquito *(Aedes) (Aedimorphus)* lokojensis sp. nov., from Northern Nigeria. Rev. de Zool. et de Bot. Africaines 59(3–4):243–248.

SICART, M. 1958. Remarques sur l'évasement des cornets respiratoires chez les nymphes du complexe *Culex pipiens.* Soc. d'Hist. Nat. Bul. (Toulouse) 93(3–4):489–490.

——— and ESCANDE, F. 1958. Quelques moustiques aberrants de l'agglomération Toulousaine. Soc. d'Hist. Nat. Bul (Toulouse) 93(1–2):39–42.

———. 1958. Sur la coloration céphalique de certaines larves d'*Anopheles maculipennis.* Soc. d'Hist. Nat. Bul. (Toulouse) 93(1–2):43–44.

SICART, M., RIOUX, J. A. and RUFFIÉ, J. 1958. Les biotypes d'*Anopheles maculipennis* dans la région de Toulouse. Soc. d'Hist. Nat. Bul. (Toulouse). 93(1–2):73–78.

THURMAN, E. B. 1959. A contribution to a revision of the Culicidae of Northern Thailand. Md. Agr. Expt. Sta. Bul. A-100, 182 pp. [Many sp. n.]

DISTRIBUTION

ANSARI, M. A. R. 1958. A report on the culicine mosquitoes in the collection of the Department of Entomology and Parasitology (Inst. Hyg. and Preventive Med.), Lahore. Pakistan Jour. Health 8(1):25–36.

CHAO, K. S., KUNG, Y. L., CH'O, H. C. and WU, C. Y. 1959. A preliminary report on the mosquitoes of Anhwei Province. Chinese Med. Jour. 78(3):280.

CHAO, Y. T. 1959. The distribution of mosquitoes in the northeastern provinces with a description of *Aedes flavescens, Aedes punctor* and *Theobaldia alaskensis.* Chinese Med. Jour. 78 (3):279. [*Culiseta alaskensis.*]

CHAPMAN, H. C. 1959. Confirmation of *Aedes schizopinax* Dyar in California (Diptera-Culicidae). Calif. Vector Views 6(9):61.

CH'IN, Y. T. 1959. Notes on some species of mosquitoes collected in the northeastern part of China with reference to distribution. Acta Ent. Sinica 9(3):272–283. In Chin., Engl. Sum.

———. and SU, L. 1959. On three species of mosquitoes newly discovered in Northeast China. Acta Ent. Sinica 9(2):195–200. In Chin., Engl. Sum. [*Aedes communis, A. cataphylla, Culiseta ochroptera.*]

GRODHAUS, G. 1959. Notes on the distribution of *Aedes schizopinax* Dyar in California. Calif. Vector Views 6(10):67.

HSICH, H. M. and YANG, C. H. 1959. Preliminary survey of mosquitoes in Tiensin. Chinese Med. Jour. 78(3):280.

JUMINER, B. 1959. Note sur l'anophélisme en Tunisie. Inst. Pasteur Tunis Arch. 36(1):37–42.

LUKASIAK, J. 1959. Appearance of mosquitoes in the eastern part of Kampinos wilderness. Acta Parasitol. Polonica (Warsaw) 7(14):307–314. In Pol., Engl. Sum.

MIHÁLYI, F. 1959. Die tiergeographische verteilung der stechmückenfauna Ungarns. Acta Zool. (Budapest) 4(3–4):393–403. [Culicidae.]

PARRISH, D. W. 1959. The mosquitoes of Turkey. Mosquito News 19(4):264–266.

SENEVET, G., ANDARELLI, L. and BUISSON, R. 1959. Une nouvelle station de *Anopheles plumbeus* en Algérie. Inst. Pasteur d'Algérie Arch. 37 (2):384.

SICART, M. and RUFFIÉ, J. 1958. Presence de *Culex torrentium* sur les montagnes de Foix. Soc. d'Hist. Nat. Bul. (Toulouse) 93(1–2):79–80.

VALKH, S. B. 1959. On the Culicidae fauna in the eastern part of the Ukraine. Med. Parazit. i Parazit. Bolezni 28(6):687–695. In Rus., Engl. Sum.

VARGAS, L. 1958. Nuevos datos sobre la distribución de anofelinos Mexicanos. Bol. Epidemiológico (Mexico) 22(2):33–53. Engl. Sum.

VELOSO, H. P. 1958. O relêvo do solo como factor determinante da distribuição dos anofelinos na Regiao "Bromeliacea-Malaria" do Brasil. Inst. Oswaldo Cruz Mem. 56(1):25–33. Engl. Sum.

WATERHOUSE, E. J. 1959. A survey of the mosquitoes of Coonalpyn Downs, South Australia. Roy. Soc. South Austral. Trans. 82:259–264.

YUAN, H. K., LIU, S. S. and HSU, S. D. 1959. A mosquito survey in some parts of Hupei Province. Acta Ent. Sinica 9(2):183–189. In Chin., Engl. Sum.

YOU, K. W. 1959. A preliminary report on the mosquitoes of Fü-chou, Kiangsi. Acta Ent. Sinica 9(2):202. In Chin.

ENCEPHALITIS

BUESCHER, E. L. and COWORKERS. 1959. Ecologic studies of Japanese encephalitis virus in Japan. 11. Mosquito infection. IV. Avian infection. Amer. Jour. Trop. Med and Hyg 8(6): 651–664; 678–688.

BUESCHER, E. L. and SCHERER, W. F. 1959. Ecologic studies of Japanese encephalitis virus in Japan IX. Epidemiologic correlations and conclusions. Amer. Jour. Trop. Med. and Hyg. 8(6): 719–722.

CHAMBERLAIN, R. W., SUDIA, W. D. and GILLETT, J. D. 1959. St. Louis encephalitis virus in mosquitoes. Amer. Jour. Hyg. 70(3):221–236.

COPPS, S. C. and GIDDINGS, L. E. 1959. Transplacental transmission of western equine encephalitis; report of a case. Pediatrics 24(1):31–33.

DAUER, C. C. 1959. Encephalomyelitis in horses. U. S. Pub. Health Rpts. 74(9):830.

DOWNS, W. G., AITKEN, T. H. G. and SPENCE, L. 1959. Eastern equine encephalitis virus isolated from *Culex nigripalpus* in Trinidad. Science 130(3387):1471.

JENKINS, A. A. and DONATH, R. 1959. The 1958 encephalitis outbreak in northern Utah. I. Human aspects. Mosquito News 19(4):221–222.

KARSTAD, L., SPALATIN, J. and HANSON, R. P. 1959. Experimental infections of wild birds with the viruses of eastern equine encephalitis, Newcastle disease and vesicular stomatitis. Jour. Infect. Dis. 105(2):188–195.

REES, D. M., OGDEN, L. J., COLLETT, G. C. and GRAHAM, J. E. 1959. The 1958 encephalitis outbreak in northern Utah. 3. Mosquito populations in relation to the outbreak. Mosquito News 19(4): 227–231.

SCHERER, W. F. and BUESCHER, E. L. 1959. Ecologic studies of Japanese encephalitis virus in Japan. I. Introduction. Amer. Jour. Trop. Med. and Hyg. 8(6):644–650.

——— and MCCLURE, H. E. 1959. Ecologic studies of Japanese encephalitis virus in Japan. V. Avian factors. Amer. Jour. Trop. Med. and Hyg. 8(6):689–697.

SCHERER, W. F. and COWORKERS. 1959. Ecologic studies of Japanese encephalitis virus in Japan. III. Mosquito factors. Zootropism and vertical flight of *Culex tritaeniorhynchus* with observations on variations in collections from animal-baited traps in different habitats. VI. Swine infection. VIII. Survey for infection of wild rodents. Amer. Jour. Trop. Med. and Hyg. 8(6):665–677; 698–706; 716–718.

SCHERER, W. F. KITAOKA, M., OKUNO, T. and OGATA, T. 1959. Ecologic studies of Japanese encephalitis virus in Japan. VII. Human infection. Amer. Jour. Trop. Med. and Hyg. 8(6):707–715.

SHUBLADZE, A. K., GAIDAMOVICH, S. IA. and GAVRILOV, V. I. 1959. Virological studies on laboratory cases of Venezuelan equine encephalomyelitis. Voprosy Virusologii (Moskva) 4(3): 305–310. In Rus. [This journal also available in English translations as Problems of Virology.]

SUDIA, W. D. 1959. The multiplication of St. Louis encephalitis virus in two species of mosquitoes: *Culex quinquefasciatus* Say and *Culex pipiens* Linnaeus. Amer. Jour. Hyg. 70(3):237–245.

THOMAS, L. A. and SMITH, J. V. 1959. The 1958 encephalitis outbreak in northern Utah. 2. Infection rates in birds, mammals, and mosquitoes. Mosquito News 19(4):223–226.

FILARIASIS

CHINESE MEDICAL JOURNAL. 1959. Single dose night treatment of filariasis with hetrazan. Chinese Med. Jour. 78(3):226–227.

FU, T. R. 1958. Experimental infection of local common mosquitoes with *Dirofilaria immitis* in Shanghai area, China. Acta Microbiol. Sinica 6(4):455–465. In Chin., Eng. Sum.

FUJISAKI, T. 1959. Supplements to the findings on the susceptibility of Japanese mosquitoes to *Wuchereria bancrofti*. 2. On the susceptibility of *Anopheles hyrcanus sinensis* and *Culex tritaeniorhynchus*. Endemic Dis. Bul. (Nagasaki Univ.) 1(3):278–287. Engl. Sum.

KUNG, C. C. 1959. Epidemiology of human filariasis in China. Its distribution and transmission. Chinese Med. Jour. 78(2):176–177.

LAING, A. B. G. 1959. The dusky leaf monkey (*Presbytis obscurus*) as a natural host of *Wuchereria malayi* in Malaya. Roy. Soc. Trop. Med. and Hyg. Trans. 53(2):213–214.

LI, H. H. 1959. Studies on filariasis in New China. Chinese Med. Jour. 78(2):148–160.

MA, H. C., YEH, Y. T., KAO, T. F. and TSAO, C. C. 1958. Filariasis along the southeastern coast of Shangtung. Acta Microbiol. Sinica 6(1): 134–139. In Chin., Engl. Sum.

RACHOU, R. G. and FERREIRA, M. O. 1958. Nota preliminar sôbre o contrôle quimioterápico da filariose bancroftiana em uma localidade so sul do Brasil. Rev. Brasil. de Malariol. 10(4): 391–395, 396. Engl. Sum.

TURNER, L. H. 1959. Studies on filariasis in Malaya: treatment of *Wuchereria malayi* filariasis with diethylcarbamazine in single daily doses. Ann. Trop. Med. and Parasitol. 53(2):180–188.

——— and SODY, L. S. 1959. Studies on filariasis in Malaya: a trial mass treatment of *Wuchereria malayi* filariasis with single daily doses of diethycarbamazine. Ann. Trop. Med. and Parasitol. 53(3):268–273.

WILCOCKS, C. 1959. Summary of recent abstracts. VII. Helminthiasis. Trop. Dis. Bul. 56(9): 905–917. [Includes filariasis.]

MALARIA

BRODY, J. A. and DUNN, F. L. 1959. Malaria surveillance in the United States. 1958. Amer. Jour. Trop. Med. and Hyg. 8(6):635–639.

CAZZOLA, D. 1959. Considerazioni sulla comparasa del paludismo in puerperio. Riv. D'Ostericia e Ginecol. Prat. (Milano) 41(5):599–601.

DUKHANINA, N. N. 1959. Prevention of malaria. Sovetskaia Meditsina 23(5):134–139. In Rus.

FRIZZI, G. 1959. I fondamentali aspetti teorici e practici di un sessantennio di ricerche per la soluzione del problema malarico in Italia. Ann. Sanità Pubblica (Roma) 20(2):227–238.

GREENBERG, J. and KENDRICK, L. P. 1959. Resistance to malaria in hybrids between Swiss and certain other strains of mice. Jour. Parasitol. 45(3):263–267.

LYSENKO, A. YA. 1959. Malaria in the Democratic Republic of Vietnam and the assistance of Soviet specialists in its control. Med. Parazit. i Parazit. Bolezni 28(5):542–548. In Rus.

MÖLLHAUSEN, W. 1959. Aspekte der malaria-

bekämpfung im westafrikanischen regenwald. Ztschr. f. Tropenmed. u. Parasitol. 10(2):159–164.

OBERDORSTER, F. 1959. Malaria in the German Democratic Republic since 1945. Med. Parazit. i Parazit. Bolezni 28(5):553–554. In Rus.

RACHOU, R. G. 1958. Novos conceitos na classificação de endemicidade malárica. Rev. Brasil. de Malariol. 10(4):297–403. Engl. Sum.

RADACOVICI, E., ATANASIU, M., ISFAN, T. and TAUTU, L. 1958. Les particularités des formes cliniques de paludisme (micorfoyers ou formes sporadiques, dans des zones soumises ou non à la desanophelisation. Studii si Cercetari Inframicrobiol. Microbiol. si Parazitol. 9(2):279–283. In Roum.

RICHTER, B. 1959. La malaria e la lotta antimalarica in Iugoslovia. Minerva Medica (Torino) 50(33):1209–1215.

SERGENT, E. 1959. Réflexions sur l'epidemiologie et l'immunologie du paludisme. Inst. Pasteur d'Algerie Arch. 37(1):1–52.

SIMKHOVICH, E. I. 1959. Quartan malaria fever at the time of malaria eradication in Moldavia. Med. Parazit. i Parazit. Bolezni 28(5):534–535. In Rus., Engl. Sum.

VELOSO, H. P. and FONTANA, P., JR. 1958. Considerações gerais sôbre o indice "M K" (Malaria-*Kerteszia*). Inst. Oswaldo Cruz Mem. 56(1):181–195. Engl. Sum.

WORLD HEALTH ORGANIZATION. 1959. Malaria information. 1959. WHO/Mal/Inform/50, 10 pp. [3rd Asian Malaria Conference, progress in Sicily, corrigendum-malaria in People's Republic of China, et al.]

Malaria—Eradication Projects

BUSLAEV, M. A. and VASYUTA, YU, S. 1959. The final stage of malaria eradication in the Russion Soviet Federative Socialist Republic. Med. Parazit. i Parazit. Bolezni 28(5):518–522. In Rus.

DEKHTSUNYAN, K. M. 1959 Elimination of malaria in the Kafan district of the Armenian SSSR. Med. Parazit. i Parazit. Bolezni 28(5): 536–540. In Rus.

HOLSTEIN, M. H. 1958. On malaria eradication in West Africa and bionomics of *Anopheles gambiae*. West Afr. Sci. Assoc. Jour. 4(2):155–162.

VARGAS, L. 1958. Aspectos socioeconómicos de las zonas rurales Mexicanas en relación con la erradicación del paludismo. Inst. de Salubridad y Enferm. Trop. (Mexico) 18(3–4):147–186.

Malaria—Plasmodia

BRAY, R. S. 1959. Pre-erythrocytic stages of human malaria parasites: *Plasmodium malariae*. Brit. Med. Jour. 5153:679–690.

HUFF, C. G., MARCHBANK, D. F. and SHIROISHI, T. 1959. Susceptibility and resistance of avian and mosquito hosts to strains of *Plasmodium relictum* isolated from pigeons. Jour. Protozool. 6(1):46–51.

INSTITUT PASTEUR DU VIÉT-NAM. 1959. Rapport annuel sur le fonctionnement technique, année 1958. 143 pp., Saigon. [Includes *Plasmodium* spp.]

JACKSON, G. J., 1959. Simultaneous infections with *Plasmodium berghei* and *Trypanosoma lewisi* in the rat. Jour. Parasitol. 45(1):94.

MAEGRAITH, B. G., DAVAKUL, K. and LEITHEAD, C. S. 1959. The terminal stages of *Plasmodium knowlesi* infection in *Macaca mulatta*. I.—The clinical state: resuscitation by L-Noradrenaline. II.—The pharmacological action of L-Noradrenaline and adrenaline. Ann. Trop. Med. and Parasitol. 53(3):358–368; 369–379.

OKPALA, I. 1958. Transmission of *Plasmodium gallinaceum* through *Aedes stokesi*. West Afr. Med. Jour. 7(n.s.)(4):195–196.

RUDZINSKA, M. A. and TRAEGER, W. 1959. Phagotrophy and two new structures in the malaria parasite *Plasmodium berghei*. Jour. Biophysical and Biochem. Cytology (New York) 6(1):103–112.

SAUTET, J., ALDIGHIERI, J., ARNAUD, G. and RAMPAL, C. 1959. Influence des vitamines B_{12}, C et K_1 dans le traitement des infections a *Plasmodium berghei* par la chloroquine. Soc. de Path. Exot. Bul. 52(3):276–281.

SERGENT, E. and PONCET, A. 1959. Des variations expérimentales de la virulence de *Plasmodium berghei;* exaltation; atténuation; mithridatisme. Inst. Pasteur d'Algérie Arch. 37(2):227–255.

Malaria—Therapeutics and Antimalarials

ARCHIBALD, H. M. and ROBERTSON, A. M. 1959. Further field trials of modern antimalarials. Jour. Trop. Med. and Hyg. (London) 62(10):241–244.

CAMPBELL, C. H. 1959. Skin pigmentation with camoquin as a malarial suppressive. Roy. Soc. Trop. Med. and Hyg. Trans. 53(2):215–216.

HURLY, M. G. D. 1959. Administration of pyrimethamine with folic and folinic acids in human malaria. Roy. Soc. Trop. Med. and Hyg. Trans. 53(5):410–411.

———. 1959. Potentiation of pyrimethamine by sulphadiazine in human malaria. Roy. Soc. Trop. Med. and Hyg. Trans. 53(5):412–413.

KALMYKOV, E. S. 1959. Antimalarial measures undertaken at various stages of malaria control in the Tadzhik SSR. Med. Parazit. i Parazit. Bolezni 28(5):528–533. In Rus., Engl. Sum.

RATHSCHECK, H. J. 1959. Klinische untersuchungsergebnisse über die parenterale verabfolgung von Propoquine (PAM-780), ein neues antimalaria-mittel. Ztschr. f. Tropenmed. u. Parasitol. 10(1):36–37. Engl. Sum.

RAY, A. P. and COWORKERS. 1959. Therapeutic response to a newer antimalarial, 377–C–54. Indian Med. Assoc. Jour. 32(10):398–401.

SAUTET, J., ALDIGHIERI, J. and ALDIGHIERI, R. 1959. Études sur la production expérimentale de la résistance a divers produits antimalariques d'une souche de *Plasmodium berghei*. Soc. de Path. Exot. Bul. 52(3):331–345.

Von Brand, T. 1959. Neuere untersuchungen aus dem gebiet de pathologischen physiologie parasitischer infektionen. Ztschr. f. Tropenmed. u. Parasitol. 10(2):135–146.

Yao, D-F. and Tang, J-Y. 1959. The antimalarial activity of dichlorophenyltriazine and other halogen substituted derivatives. Acta Pharmaceutica Sinica 7(2):84–89. In Chin., Engl. Sum.

YELLOW FEVER

Meers, P. D. 1959. Smallpox—17D vaccine. Roy. Soc. Trop. Med. and Hyg. Trans. 53(3):296.

Porterfield, J. S. 1959. A plaque technique for the titration of yellow fever virus and antisera. Roy. Soc. Trop. Med. and Hyg. Trans. 53(6):458–466.

OTHER DISEASES

Gutzevich, A. V. and Podolyan, V. J. 1959. Studying of mosquitoes in connection with their role as vectors of the neurotropic viruses in the Western Ukraine. Zool. Zh. (Moskva) 38(3): 443–448. In Rus., Engl. Sum.

Holden, P. and Hess, A. D. 1959. Cache Valley virus, a previously undescribed mosquito-borne agent. Science 130(3383):1187. [Isolated from *Culiseta inornata*.]

Woodall, J. P. and Bertram, D. S. 1959. The transmission of Semliki Forest virus by *Aedes aegypti* L. Roy. Soc. Trop. Med. and Hyg. Trans. 53(6):440–444.

———. 1959. Semliki forest virus and its transmission by *Aedes aegypti* L. Internatl. Cong. Zool. Proc. 15:701–702.

LIGHT TRAP STUDIES

Blakeslee, T. E., Axtell, R. and Johnston, L. 1959. *Aedes vexans* and *Culex salinarius* light trap collections at five elevations. Mosquito News 19(4):283.

Loomis, E. C. 1959. Selective responses of *Aedes nigromaculis* (Ludlow) to the Minnesota light trap. Mosquito News 19(4):260–263.

LITERATURE REFERENCES AND REVIEWS

Dukhanina, N. N. 1959. Native literature treating the problems of medical parasitology and parasitic diseases in the second quarter of 1959. Med. Parazit. i Parazit. Bolezni 28(5):623–631. In Rus.

———. 1959. Native literature on the problems of medical parasitology and parasitic diseases for the third quarter of 1959. Med. Parazit. i Parazit. Bolezni 28(6):744–752. In Rus. [Both references include mosquitoes and malaria.]

Sollers, H. 1959. References to literature of interest to mosquito workers and malariologists. Mosquito News 19(4):292–300.

BIOGRAPHY AND HISTORY

Peller, S. 1959. Walter Reed, C. Finlay and their predecessors around 1800. Bul. Hist. Med. 33(3):195–211.

White, C. R. 1959. Yellow fever; history of the disease in the eighteenth and nineteenth century. Kansas Med. Soc. Jour. 60(8):298–302.

SUBJECTS NOT COVERED BY OTHER HEADINGS

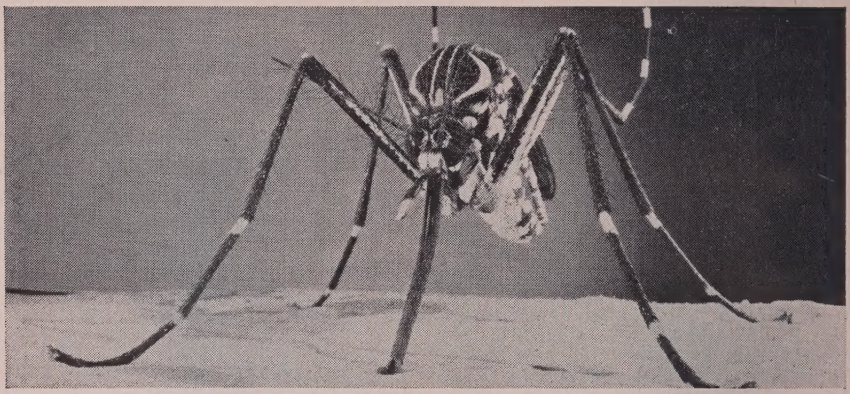
Eskin, V. A., Dandurov, Iu. V. and Kalinkovskii, I. S. 1959. Canopy of mosquito protection. Voenno-Meditsinskii Zhur. (Moskva) 6:89–90. In Rus.

Lang, C. A. 1959. Cytochrome C reductase activities during development. Expt. Cell. Res. (N. Y.) 17(3):516–518. [Mosquitoes.]

New Jersey Agricultural Experiment Station. 1959. The story of the mosquito. N. J. Agr. Expt. Sta. Cir. 585, 15 pp.

Pan American Sanitary Bureau. 1959. Annual report of the Director, 1958. Pan. Amer. Health Organ. Off. Doc. 165 pp., Washington, D. C.

World Health Organization. 1959. Executive Board. Twenty-fourth session Geneva, 1 and 2 June 1959. Resolutions annexes. WHO Off. Rec. 96, 64 pp.



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